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Energy Research Abstracts

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Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Coverage

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports and patent applications originated by the U.S. Department of Energy, its laboratories, energy centers, and contractors, as well as theses and conference papers and proceedings issued by these organizations in report form. Audiovisual materials, computer media (magnetic tapes, diskettes, etc.), and engineering drawings are included in this definition. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations, *provided* that the full text of the document has been received by OSTI. Foreign report information is obtained through the International Energy Agency's 15-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. The purpose of this publication is to announce documents produced or obtained by DOE that are not so readily available as journal articles, books, or patents.

Scope

The scope of *ERA* encompasses DOE's research, development, demonstration, and technology programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

The citations presented in *ERA* are available for online searching as records within the Energy Science and Technology Database (EDB). The current-year records are available on the Integrated Technical Information System (ITIS).

Availability

DOE and DOE contractors can obtain *ERA* (regular issues and annual indexes) by using VISA, MasterCard, or OSTI deposit accounts. Contact the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831, Attention: Information Services. For further information, call (615)576-8401. *ERA* is also available at authorized GPO Depository Libraries. (List is provided on the inside back cover.)

ERA (regular issues and annual indexes) is available to the public on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Managing Editor, Doris M. Henline
Technical Editor, Milton O. Whitson

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

The **Energy Technology Data Exchange (ETDE)** was established by the International Energy Agency to promote cooperation among members in conducting appropriate energy-related research and development programs through the development of a formal central information sharing system. In accomplishing the objectives of the ETDE, members select, abstract, and index relevant research information published in their countries in accordance with Exchange standards. OSTI serves as the central receiving and processing center for this information, which it then disseminates to national centers in the participating countries. The following countries are currently members of the ETDE:

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Finland
France
Germany
Italy
Japan
Republic of Korea
The Netherlands
Norway
Spain
Sweden
Switzerland
United Kingdom
United States

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The principal data elements included in these citations are:

1. **Abstract number** within volume.
2. **Report number** identification for report-type literature.
3. **Title and subtitle** (non-English title may appear in parentheses, if applicable).
4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Date of publication.** If not known, a processing date is in brackets.
9. **Number of pages** or page range. Prices are based on total pages unless special pricing applies.
10. **Language** of document if non-English.
11. **Monograph title** if citation is an analytic (part, chapter, or paper) of a larger monograph.
12. **Sponsoring organization.**
13. **Contract or grant number.**
14. **Secondary identifying number;** may be a conference number.
15. **Conference title, location, and date,** if applicable.
16. **Order number.** The "DE" order number may be used for ordering from NTIS or OSTI, as appropriate. The "TI" prefix is valid only at OSTI.
17. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
18. **Drop note** or explanatory statement.
19. **Abstract.**
20. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

54 (DOE/ER/60888-1-Vol.1, pp. 115-117) **Investigation of air pollution in house due to use of various fuels.** Luo, Dayu (Chengdu Sanitation (China)). Canada Mortgage and Housing Corp., Ottawa, ON (Canada). 1990. (CONF-900724-Vol.1: Indoor Air '90: 5th international conference on indoor air quality and climate, Toronto (Canada), 29 Jul - 3 aug 1990). In Indoor air '90: The fifth international conference on indoor air quality and climate. Volume 1: Final report. 786p. Order Number DE90017786. Source: NTIS.

Air pollution in houses caused by combustion of coal is more serious than that by combustion of natural gas and methane (primarily by SO_2 and NO_2). The gas concentration after cooking is higher than that before cooking, and it is higher in kitchen than in bedroom and outdoor. There were mutations in the extract from TSP in $30m^2$ air in the bedroom, kitchen and outdoor, where coal and natural gas were used. The supernatant saliva activity of children whose family uses coal is significantly lower than that of pumping streams.

How To Order from the Availability Sources

TO OBTAIN A REPORT

Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 2 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) OSTI prices are based on total pages unless special pricing applies. The public should order from NTIS or from one of the other agencies listed in the citation. NTIS price codes may continue to appear in some records. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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Government Printing Office
Washington, DC 20402

GPO Dep. Available for inspection or interlibrary loan at Government Printing Office regional depository libraries.

INIS *Available only in microfiche.*
INIS Clearinghouse
International Atomic Energy Agency
P.O. Box 100, A-1400
Vienna, Austria

NTIS U.S. Department of Commerce
Technology Administration
National Technical Information Service
Springfield, VA 22161

OSTI U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831

ESTSC Energy Science and Technology Software Center
P.O. Box 1020
Oak Ridge, TN 37831-1020

How To Use the Indexes

Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts*. Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
See also DEUTERIUM
HYDROGEN 4
TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
15:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**

Report Number Index
Technical report literature is indexed by the alpha-numerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

DOE/ER/40438– T1 15:18494 NTIS, OSTI E 1.99: DE89007246 MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 38 first-level and the 313 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in ETDE/PUB--1-R2, *International Energy: Subject Categories and Scope.*

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

6008 (PETC–94005180) **PETC review: Issue 9.** Santore, R.R.; Friedman, S.; Reiss, J.; Waehner, M.J. (eds.). USDOE Pittsburgh Energy Technology Center, PA (United States). Fal 1993. 56p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94005180. Source: OSTI; NTIS; GPO Dep.

Since its beginning, Pittsburgh Energy Technology Center's (PETC) primary function has been to study and conduct research on coal and its uses and applications. PETC has also been investigating ways in which natural gas can be employed to enhance the use of coal and to convert natural gas into liquid products that can be more readily transported and stored. This review contains five articles which reflect PETC's mission: State-of-the-Art High Performance Power Systems [HIPPS]; Unconventional Fuel Uses of Natural Gas; Micronized Magnetite – Beneficiation and Benefits; Reburning for NO_x Reduction; and An Update of PETC's Process Research Facility.

0103 Preparation

Refer also to citation(s) 6033, 6047, 6077

6009 (DOE/PC/79867–T1) **Advanced physical fine coal cleaning spherical agglomeration: Final report.** Bechtel Corp., Homer City, PA (United States). Sep 1990. 222p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-87PC79867. Order Number DE94003776. Source: OSTI; NTIS; GPO Dep.

The project included process development, engineering, construction, and operation of a 1/3 tph proof-of-concept (POC) spherical agglomeration test module. The POC tests demonstrated that physical cleaning of ultrafine coal by agglomeration using heptane can achieve: (1) Pyritic sulfur reductions beyond that possible with conventional coal cleaning methods; (2) coal ash contents below those which can be obtained by conventional coal cleaning methods at comparable energy recoveries; (3) energy recoveries of 80 percent or greater measured against the raw coal energy content; (4) complete recovery of the heptane bridging liquid from the agglomerates; and (5) production of agglomerates with 3/8-inch size and less than 30 percent moisture. Test results met or exceeded all of the program objectives. Nominal 3/8-inch size agglomerates with less than 20 percent moisture were produced. The clean coal ash content varied between 1.5 to 5.5 percent by weight (dry basis) depending on feed coal type. Ash reductions of the run-of-mine (ROM) coal were 77 to 83 percent. ROM pyritic sulfur reductions varied from 86 to 90 percent for the three test coals, equating to total sulfur reductions of 47 to 72 percent.

6010 (DOE/PC/79867–T1-App.) **Advanced physical fine coal cleaning spherical agglomeration: Final report, Appendices.** Bechtel Corp., Homer City, PA (United States). Sep 1990. 574p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-87PC79867. Order Number DE94003845. Source: OSTI; NTIS; GPO Dep.

This appendix consists entirely of experimental data; no text.

6011 (DOE/PC/88879–T7) **Engineering development of selective agglomeration: Trace element removal study.** CQ, Inc., Homer City, PA (United States); Southern Co. Services, Inc., Birmingham, AL (United States). Sep 1993. 175p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-89PC88879. Order Number DE94004514. Source: OSTI; NTIS; GPO Dep.

Southern Company Services, Inc., (SCS) was contracted in 1989 by the US Department of Energy (DOE) to develop a commercially acceptable selective agglomeration technology to enhance the use of high-sulfur coals by 1993. The project scope involved development of a bench-scale process and components, as well as the design, testing, and evaluation of a proof-of-concept (POC) facility. To that end, a two-ton-per-hour facility was constructed and tested near Wilsonville, Alabama. Although it was not the primary focus of the test program, SCS also measured the ability of selective agglomeration to remove trace elements from coal. This document describes the results of that program.

6012 (DOE/PC/90287–T12) **Oxidation of coal and coal pyrite mechanisms and influence on surface characteristics: Technical progress report, [June–August 1993].** Doyle, F.M. California Univ., Berkeley, CA (United States). Dept. of Materials Science and Mineral Engineering. 30 Sep 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-90PC90287. Order Number DE94004525. Source: OSTI; NTIS; GPO Dep.

The objective of this research is to develop a mechanistic understanding of the oxidation of coal and coal pyrite, and to correlate the intrinsic physical and chemical properties of these minerals, along with changes resulting from oxidation, with those surface properties that influence the behavior in physical cleaning processes. The results will provide fundamental insight into oxidation, in term of the bulk and surface chemistry, the microstructure, and the semiconductor properties of the pyrite. During the twelfth quarter, wet and dry oxidation tests were done at room temperature on coal samples from the Pennsylvania State Coal Bank. Previous results had indicated that oxidation at high temperatures induced changes in surface properties through loss of volatiles. As-received and oxidized coal samples were studied by ion exchange methods to determine the carboxylate and phenolic group concentrations. Film flotation tests were done to characterize the floatability of as-received and oxidized coals. Surface area measurements were done on as-received coals.

6013 (DOE/PC/91280–T9) **Coal-sand attrition system and its' importance in fine coal cleaning: Eighth quarterly report, June 1, 1992–August 31, 1993.** Mehta, R.K.; Schultz, C.W. Alabama Univ., University, AL (United States). Mineral Resources Inst. 26 Aug 1993. 53p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91280. Order Number DE94001981. Source: OSTI; NTIS; GPO Dep.

The research efforts on the importance of a coal-sand attrition continued with work in four categories: Continuous grinding tests using steel media; fracture tests on coal samples compacted at different pressure; SEM-Image analysis of feed and ground product coal samples; zeta potential measurements of coal samples ground by different media, and flotation test of coal samples ground by different media. Results are described.

6014 (DOE/PC/92206–T2) **Bench scale testing of micronized magnetite beneficiation: Quarterly technical progress report No. 1, January–March 1993.** Anast, K. AMAX Research and Development Center, Golden, CO (United States). 1 Sep 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC92206. Order Number DE94003300. Source: OSTI; NTIS; GPO Dep.

This project is aimed at development of a process that, by using ultra fine magnetite suspension, would expand the application of heavy media separation technology to processing fine, –28 mesh coals. These coal fines, produced during coal mining and crushing, are separated in the conventonal coal preparation plant and generally impounded in a tailings pond. Development of an economic process for processing these fines into marketable product will expand the utilization of coal for power production in an environmentally acceptable and economically viable way. This process has been successfully researched at PETC but has not been studied on a continuous bench-scale unit, which is a necessary step towards commercial development of this promising technology. The goal of the program is to investigate the technology in a continuous circuit at a reasonable scale to provide a design basis for larger plants and a commercial feasibility data.

6015 (DOE/PC/92546–T4) **New concept for coal wettability evaluation and modulation: Technical progress report, July 1, 1993–September 30, 1993.** Hu, Weibai. Utah Univ., Salt Lake City, UT (United States). [1993]. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92546. Order Number DE94003630. Source: OSTI; NTIS; GPO Dep.

The ratio of kinetics of capillary rise test between different media is a measure of relative wettability. From table 1, 2 and 3, the Hu's evaluation of wettability of five samples in the methanol, ethanol and propanol are shown that the kinetic wettability is dependent on the carbon homologous series of alcohol, as shorter the carbon chain of the alcohol, the better surface wettability. The Hu's evaluation of wettability of $H_{H2O}/H_{methanol}$, $H_{H2O}/H_{ethanol}$, and $H_{H2O}/H_{propanol}$ for five samples are listed respectively in table 4, 5 and 6. It indicates that in the water/methanol, water/ethanol, and water/propanol system, Upper Freeport Coal is very little hydrophilicity, or better floatability than Coal Pyrite, it also can be seen that in these system, Pittsburgh No.8 Coal have a little hydrophilicity, or better floatability than Coal pyrite, it would mean that if Methanol, Ethanol, and Propanol are used as flotation collector, coal will be selectively separated from coal pyrite. This has been verified by our investigation elsewhere. The Hu's evaluation of wettability of $H_{methanol}/H_{kerosene}$ for five samples are listed in table 7. It is very interesting to note that the five samples have more methanol-philicity than kerosene. This is very useful for flotation reagents evaluation and selection in practice. The Hu's evaluation of wettability of $H_{ethanol}/H_{kerosene}$ for five samples are listed in table 8. It is indicated that ethanol also can be used as flotation collector. The Hu's evaluation of wettability $H_{propanol}/H_{kerosene}$ for five samples are listed in table 9. It shows that the five samples have lower propanol-philicity than kerosene.

6016 (DOE/PC/92547–T2) **Studies of incipient oxidation of coal-pyrite for improved pyrite rejection: Third quarterly technical progress report, April 1, 1993–June 30, 1993.** Yoon, R.H.; Richardson, P.E. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (United States). Dept. of Mining and Minerals Engineering. [1993]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92547. Order Number DE94003288. Source: OSTI; NTIS; GPO Dep.

The initial stages of pyrite oxidation are being studied to develop methods to control pyrite surface chemistry and foster pyrite rejection in coal flotation circuits. A major objective of this work is to study incipient oxidation, which is accomplished by fracturing pyrite electrodes in an electrochemical cell. It has been shown that by holding the potential at various values during fracture and measuring the current passed at fracture, pyrite oxidation or reduction can be precisely controlled. The oxidation and reduction products on pyrite following fracture are being studied by a combination of voltammetry, photocurrent, and impedance spectroscopy techniques. During this report period, major effort was devoted to characterizing the surfaces by impedance spectroscopy.

6017 (EGG-M–93358) **A combined physical/microbial process for coal beneficiation.** Noah, K.S.; Glenn, A.W.; Stevens, C.J.; McAtee, N.B.; McIlwain, M.E.; Andrews, G.F. EG and G Idaho, Inc., Idaho Falls, ID (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. (CONF-9309111–5: 10. annual international Pittsburgh coal conference: coal - energy and the environment, Pittsburgh, PA (United States), 20-24 Sep 1993). Order Number DE94002895. Source: OSTI; NTIS; GPO Dep.

A combined physical/microbial process for the removal of pyritic sulfur from coal was demonstrated in a 200 L aerated trough slurry reactor. The reactor was divided into six sections, each of which acted as both a physical separator and a bioreactor. Settled solids from sections 2 through 6 were recycled to section 1 which acted as a rougher. The objective was physical removal of the larger pyritic inclusions, which would take many days to biodegrade, and biodegradation of the micropyrite, which is difficult to remove physically. The process was operated continuously for 8 months, treating two Illinois No. 6 coals (4 months each). Reduction of 90% in-pyritic sulfur with 90% energy recovery and 35% ash removal was obtained for a low pyrite Monterey coal at a 5 day coal retention time and 20% (w/w) slurry concentration. Increased coal loading reduced performance apparently due to losses of sulfur oxidizing bacteria. A low pyrite Consol coal gave 63–77% pyrite reduction with 23–30% ash removal and 77–90% heating value recovery. Product coal pyritic sulfur analysis indicated no differences between treatments of Consol coal. This suggests that the coal residence time could be further reduced and the slurry concentration increased in future work.

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Refer also to citation(s) 6048, 6049, 6078, 6455, 6569, 6575

6018 (CONF-9309270–1) **Hydrodynamic behavior of a liquid-solid fluidized-bed reactor for the bioconversion of coal particles to liquid products.** Scott, T.C. (Oak Ridge National Lab., TN (United States)); Kaufman, E.N.; Cosgrove, J.M.; Asif, M.; Petersen, J.N. Oak Ridge National Lab., TN (United States). [1993]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 4. international symposium on the biological processing of fossil fuels; Alghero (Italy); 21-23 Sep 1993. Order Number DE94001127. Source: OSTI; NTIS; GPO Dep.

A predictive mathematical model based on particle convection and dispersion is presented for a liquid fluidized bed of coal particles. The numerical representation can follow transient behavior of liquid fluidized beds that contain a defined particle-size distribution. The calculations exhibited excellent agreement when compared to experimental transient pressure-drop data from a column containing particles of Illinois No. 6 bituminous coal in the size range of 20 to 120 μm. In addition, the model was used to simulate the effect of periodic (hourly) liquid velocity step changes on elutriation of small particles from a given particle-size distribution of 34.5 to 75.5 μm. For the situation tested, the calculations indicate that (a) the column does not reach a steady state between velocity changes and (b) that higher initial particle elutriation rates decay to lower values until no more particles elutriate from the column.

6019 (DOE/FTR–93018045) **Travel to Japan to carry out several activities to Coal Energy Research and Development: Foreign trip report, October 17–29, 1991.** Chun, Sun W. (US-DOE Pittsburgh Energy Technology Center, PA (United States)); Torkos, T.; McGurl, G.; Lee, S.; Klunder, E.; Cugini, A.; Wilson, J.; Judkins, R. USDOE Pittsburgh Energy Technology Center, PA (United States). [1991]. 24p. Sponsored by USDOE, Washington, DC (United States). Order Number DE93018045. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This trip included the Sixth Annual Meeting of the US DOE, Japan AIST/ANRE Coordinating Committee on Coal Energy Research and Development; the Eighth Annual Joint Technical Meeting on Coal Liquefaction; the Third Annual Joint Meeting on Materials for Coal Liquefaction; and meetings of subcommittees on Coal Liquefaction and Materials for Coal Liquefaction. The subcommittee meetings resulted in completion of annual implementation plans for 1992. At the Joint Coordinating Committee meeting, dates and locations were selected for the 1992 meetings of the Joint Coordinating Committee and the Liquefaction Technical meetings. Agreement in principle was reached on the 1992 implementation plans and an extension to the work statements in four areas; however, these could not be signed because DOE clearance was not complete. The technical meetings in Coal Liquefaction and Materials for Coal Liquefaction were completed with excellent presentations made by personnel from both countries. The new poster session was especially useful in aiding detailed technical discussions. Following the meetings there was a technical tour of research facilities in Kyushu and the Tokyo area.

6020 (DOE/MC/24257–3499) **Integrated Low Emissions Cleanup system for direct coal fueled turbines.** Newby, R.A.; Alvin, M.A.; Bachovchin, D.M.; Smeltzer, E.E.; Lippert, T.E. Westinghouse Electric Corp., Pittsburgh, PA (United States). Science and Technology Center. Jul 1993. 51p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-87MC24257. Order Number DE94000031. Source: OSTI; NTIS; GPO Dep.

The United States Department of.Energy, Morgantown Energy Research Center (DOE/METC), is sponsoring the development of coal-fired turbine technology in the areas of Pressurized Fluidized

Bed Combustion, Integrated Gasification Combined Cycles, and Direct Coal-Fired Turbines. A major technical challenge remaining for the development of coal-fired turbine systems is high-temperature gas cleaning to meet environmental standards for sulfur oxides and particulate emissions, as well as to provide acceptable turbine life. The Westinghouse Electric Corporation, Science & Technology Center, is evaluating an Integrated Low Emissions Cleanup (ILEC) concept that has been configured to meet this technical challenge. This ceramic barrier filter, ILEC concept simultaneously controls sulfur, particulate, and alkali contaminants in high-pressure fuel gases or combustion gases, and is considering cleaning temperatures up to 2100°F. This document describes Phase II of the program, the design, construction, and shakedown of a bench-scale facility to test and confirm the feasibility of this ILEC technology.

6021 (DOE/MC/25003–3495) **Enhanced durability of high-temperature desulfurization sorbents for moving-bed applications: Option 2 Program: Development and testing of zinc titanate sorbents.** Ayala, R.E. General Electric Co., Schenectady, NY (United States). Corporate Research and Development Center. Apr 1993. 51p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-88MC25003. Order Number DE94000028. Source: OSTI; NTIS; GPO Dep.

One of the most advantageous configurations of the integrated gasification combined cycle (IGCC) power system is coupling it with a hot gas cleanup for the more efficient production of electric power in an environmentally acceptable manner. In conventional gasification cleanup systems, closely heat exchangers are necessary to cool down the fuel gases for cleaning, sometimes as low as 200–300°F, and to reheat the gases prior to injection into the turbine. The result is significant losses in efficiency for the overall power cycle. High-temperature coal gas cleanup in the IGCC system can be operated near 1000°F or higher, i.e., at conditions compatible with the gasifier and turbine components, resulting is a more efficient overall system. GE is developing a moving-bed, high-temperature desulfurization system for IGCC power systems in which mixed-metal oxides are currently being used as desulfurization sorbents. The objective of this contract is to identify and test fabrication methods and sorbent chemical compositions that enhance the long-term chemical reactivity and mechanical durability of zinc ferrite and other novel sorbents for moving-bed, high-temperature desulfurization of coal-derived gases. Zinc ferrite was studied under the base program of this contract. In the next phase of this program novel sorbents, particularly zinc titanate-based sorbents, are being studied under the remaining optional programs. This topical report summarizes only the work performed under the Option 2 program. In the course of carrying out the program, more than 25 zinc titanate formulations have been prepared and characterized to identify formulations exhibiting enhanced properties over the baseline zinc titanate formulation selected by the US Department of Energy.

6022 (DOE/MC/27226–3568) **Development of biological coal gasification (MicGas process): 12th Quarterly report.** ARCTECH, Inc., Chantilly, VA (United States). 29 Jul 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-90MC27226. Order Number DE94005302. Source: OSTI; NTIS; GPO Dep.

Several experiments were conducted to study the efficiency of granulated sludge consortium (GSC) on the biomethanation of Texas lignite (TxL). With an aim of obtaining a better culture than Mic-1, GSC was used as inoculum at different concentrations. The first experiment was conducted under anaerobic conditions in 60-mL vials containing 40 mL 0.01% SNTM + 1% TxL + 10% GSC. Methane production was measured periodically in the vial headspace and after 20 days of incubation, methane was found to be up to 67 mole%. The second experiment was conducted to determine whether methane production was from biogasification of coal or from substrates used for growing the GSC. The effect of two different anaerobic conditions on biomethanation of Texas lignite was also studied.

6023 (DOE/PC/89775–14) **Control of catalytic hydrotreating selectivity with ammonia: [Quarterly] report, July 1, 1993–September 30, 1993.** Satterfield, C.N.; Gultekin, S. Massachusetts Inst. of Tech., Cambridge, MA (United States). [1993]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-89PC89775. Order Number DE94003573. Source: OSTI; NTIS; GPO Dep.

For the model reaction studied, the addition of NH_3 increases the selectivity towards ring hydrogenation (generally desired) and away from dealkylation (generally undesired). However the overall reaction rate for a fixed temperature drops substantially. Selectivity is the greatest at the lowest temperatures. The effect of NH_3 is less than proportional to its partial pressure. The results obtained here suggest how operating conditions might be adjusted to obtain an optimum amongst desired reaction rates, conversion and selectivity, in the presence of small concentrations of NH_3 or other bases.

6024 (DOE/PC/90042–T6) **Development of a catalyst for conversion of syngas-derived materials to isobutylene: Technical progress report No. 4, January 1, 1992–March 30, 1992.** Gajda, G.J. UOP, Inc., Des Plaines, IL (United States). 10 Sep 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90042. Order Number DE94004537. Source: OSTI; NTIS; GPO Dep.

The main goal of this contract is to develop a catalyst and technology that will produce $iC_{4=}$ directly from coal-derived syngas and that is capable of using a lower H_2/CO ratio (0.5 to 1.0). The research will identify and optimize the key catalyst and process characteristics that give improved performance for CO conversion by a non-Fischer-Tropsch process. This report, which is the Technical Progress Report No. 4 for contract DE-AC22-91PC90042, covers the testing of various ZrO_2-based catalyst systems designed to examine the effects of catalyst preparation and process variables, especially the H_2/CO ratio. Testing of sol-gel ZrO_2 catalysts with 1 or 2% cesium (Cs) addition indicates decreased stability at a H_2:CO ratio of 0.5. The addition of cobalt (Co) or copper (Cu) to the base ZrO_2 catalyst results in a small activity gain, but a selectivity loss. This gain in Cu catalyst activity is mostly due to increased methane production. The Co catalyst shifts selectivity toward saturated products. The addition of water to the feed stream had a beneficial effect on stability. The addition of a basic clay had no effect on the activity or selectivity.

6025 (DOE/PC/90046–T7) **Heterogeneous catalytic process for alcohol fuels from syngas: Fifth quarterly technical progress report, January–March 1993.** Bassett, M.R.; Minahan, D.M.; Nagaki, D.A. Union Carbide Chemicals and Plastics Co., Inc., South Charleston, WV (United States). South Charleston Technical Center. 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90046. Order Number DE94003337. Source: OSTI; NTIS; GPO Dep.

As stated last quarter, we discovered potassium as an impurity in the mixed metal oxides. The potassium was probably incorporated into the solid during the coprecipitation using K_2CO_3. Currently NH_4OH is being used as the precipitating base. We have discovered that the precipitation agent influences the surface composition of the mixed-metal oxides. Chemical analysis of the surface and bulk compositions showed significant differences in surface compositions of the K_2CO_3 and NH_4OH precipitated catalysts. In TPR experiments we have discovered that the precipitating pH markedly affects the reducibility of the ZnMnCr oxides. This shows that the choice of base as well as the pH strongly affects the surface composition of the mixed metal catalysts. Additional studies are in progress in which we are studying how the precipitating agents affect the surface composition of the mixed metal oxide catalysts and how the different surface compositions affect their chemical properties and their interactions with the supported metal particles. Catalysts from our last design show a total selectivity to alcohols of 86%, a 3:1 ratio of methanol to isobutanol and an isobutanol productivity of 30–38 g/kg-hr. Process conversion is estimated to be 7–8%. These are encouraging results, and it is hoped that manipulation of process variables such as temperature, pressure, syngas ratio and space velocity will lead to further improved performance.

6026 (DOE/PC/90055–T7) **Technology development for iron Fischer-Tropsch catalysts: Technical progress report No. 6, December 26, 1991–March 31, 1992.** Frame, R.R.; Gala, H.B. UOP, Inc., Des Plaines, IL (United States). [1992]. 52p. Sponsored

by USDOE, Washington, DC (United States). DOE Contract AC22-90PC90055. Order Number DE94005026. Source: OSTI; NTIS; GPO Dep.

The objective of this contract are to develop a technology for the production of active and stable iron Fischer-Tropsch catalysts for use in slurry-phase synthesis reactors and to develop a scaleup procedure for large-scale synthesis of such catalysts for process development and long-term testing in slurry bubble-column reactors. With a feed containing H_2 and CO in the molar ratio of 0.5 to 1.0 to the slurry bubble-column reactor, the catalyst performance target is 88% CO + H_2 conversion at a minimum space velocity of 2.4 NL/hr/gFe. The desired sum of methane and ethane selectivities is no more than 4%, and the conversion loss per week is not to exceed 1%. Contract Tasks are as follows: 1.0–Catalyst development, 1.1–Technology assessment, 1.2–Precipitated catalyst preparation method development, 1.3–Novel catalyst preparation methods investigation, 1.4–Catalyst pretreatment, 1.5–Catalyst characterization, 2.0–Catalyst testing, 3.0–Catalyst aging studies, and 4.0–Preliminary design and cost estimate of a catalyst synthesis facility. This paper reports progress made on catalyst development.

6027 (DOE/PC/90055–T8) **Technology development for iron Fischer-Tropsch catalysts: Technical progress report No. 7, April 1, 1992–June 30, 1992.** Frame, R.R.; Gala, H.B. UOP, Inc., Des Plaines, IL (United States). [1992]. 76p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-90PC90055. Order Number DE94005027. Source: OSTI; NTIS; GPO Dep.

The objective of this contract are to develop a technology for the production of active and stable iron Fischer-Tropsch catalysts for use in slurry-phase synthesis reactors and to develop a scaleup procedure for large-scale synthesis of such catalysts for process development and long-term testing in slurry bubble-column reactors. With a feed containing H_2 and CO in the molar ratio of 0.5 to 1.0 to the slurry bubble-column reactor, the catalyst performance target is 88% CO + H_2 conversion at a minimum space velocity of 2.4 NL/hr/gFe. The desired sum of methane and ethane selectivities is no more than 4%, and the conversion loss per week is not to exceed 1%. Contract Tasks are as follows: 1.0–Catalyst development, 1.1–Technology assessment, 1.2–Precipitated catalyst preparation method development, 1.3–Novel catalyst preparation methods investigation, 1.4–Catalyst pretreatment, 1.5–Catalyst characterization, 2.0–Catalyst testing, 3.0–Catalyst aging studies, and 4.0–Preliminary design and cost estimate of a catalyst synthesis facility. This paper reports progress made on catalyst development.

6028 (DOE/PC/90055–T9) **Technology development for iron Fischer-Tropsch catalysts: Technical progress report No. 8, July 1, 1992–September 30, 1992.** Frame, R.R.; Gala, H.B. UOP, Inc., Des Plaines, IL (United States). [1992]. 61p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-90PC90055. Order Number DE94005028. Source: OSTI; NTIS; GPO Dep.

The objectives of this contract are to develop a technology for the production of active and stable iron Fischer-Tropsch catalysts for use in slurry-phase synthesis reactors and to develop a scaleup procedure for large-scale synthesis of such catalysts for process development and long-term testing in slurry bubble-column reactors. With a feed containing hydrogen and carbon monoxide in the molar ratio of 0.5 to 1.0 to the slurry bubble-column reactor, the catalyst performance target is 88% CO + H_2 conversion at a minimum space velocity of 2.4 NL/hr/gFe. The desired sum of methane and ethane selectivities is no more than 4%, and the conversion loss per week is not to exceed 1%. Contract Tasks are as follows: 1.0–Catalyst development, 1.1–Technology assessment, 1.2–Precipitated catalyst preparation method development, 1.3–Novel catalyst preparation methods investigation, 1.4–Catalyst pretreatment, 1.5–Catalyst characterization, 2.0–Catalyst testing, 3.0–Catalyst aging studies, and 4.0–Preliminary design and cost estimate of a catalyst synthesis facility. This paper reports progress made on Task 1.

6029 (DOE/PC/90055–T10) **Technology development for iron Fischer-Tropsch catalysts: Technical progress report No. 9, September 26, 1992–December 26, 1992.** Frame, R.R.; Gala, H.B. UOP, Inc., Des Plaines, IL (United States). [1992]. 48p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-90PC90055. Order Number DE94005029. Source: OSTI; NTIS; GPO Dep.

The objectives of this contract are to develop a technology for the production of active and stable iron Fischer-Tropsch catalysts for use in slurry-phase synthesis reactors and to develop a scaleup procedure for large-scale synthesis of such catalysts for process development and long-term testing in slurry bubble-column reactors. With a feed containing hydrogen and carbon monoxide in the molar ratio of 0.5 to 1.0 to the slurry bubble-column reactor, the catalyst performance target is 88% CO + H_2 conversion at a minimum space velocity of 2.4 NL/hr/gFe. The desired sum of methane and ethane selectivities is no more than 4%, and the conversion loss per week is not to exceed 1%. Contract Tasks are as follows: 1.0–Catalyst development, 1.1–Technology assessment, 1.2–Precipitated catalyst preparation method development, 1.3–Novel catalyst preparation methods investigation, 1.4–Catalyst pretreatment, 1.5–Catalyst characterization, 2.0–Catalyst testing, 3.0–Catalyst aging studies, and 4.0–Preliminary design and cost estimate of a catalyst synthesis facility. This paper reports progress on Task 1.3.

6030 (DOE/PC/90055–T11) **Technology development for iron Fischer-Tropsch catalysts: Technical progress report No. 10, December 26, 1992–March 26, 1993.** Frame, R.R.; Gala, H.B. UOP, Inc., Des Plaines, IL (United States). [1993]. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-90PC90055. Order Number DE94005030. Source: OSTI; NTIS; GPO Dep.

The objectives of this contract are to develop a technology for the production of active and stable iron Fischer-Tropsch catalysts for use in slurry-phase synthesis reactors and to develop a scaleup procedure for large-scale synthesis of such catalysts for process development and long-term testing in slurry bubble-column reactors. With a feed containing hydrogen and carbon monoxide in the molar ratio of 0.5 to 1.0 to the slurry bubble-column reactor, the catalyst performance target is 88% CO + H_2 conversion at a minimum space velocity of 2.4 NL/hr/gFe. The desired sum of methane and ethane selectivities is no more than 4%, and the conversion loss per week is not to exceed 1%. Contract tasks are as follows: 1.0: Catalyst development; 1.1–Technology assessment; 1.2–Precipitated catalyst preparation method development; 1.3–Novel catalyst preparation methods investigation; 1.4–Catalyst pretreatment; 1.5–Catalyst characterization; 2.0–Catalyst testing; 3.0–Catalyst aging studies, and 4.0–Preliminary design and cost estimate of a catalyst synthesis facility. This paper reports progress made on Task 1.2 and 2.0.

6031 (DOE/PC/90304–T5) **Selective solvent absorption in coal conversion: Quarterly report, July 1, 1992–September 30, 1992.** Larsen, J.W.; Amui, J. Lehigh Univ., Bethlehem, PA (United States). Dept. of Chemistry. [1992]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-90PC90304. Order Number DE94002659. Source: OSTI; NTIS; GPO Dep.

The objectives of this program include: Determine the importance of the presence of added hydrogen donor compounds within the coal in the first stage of direct liquefaction processes; and to determine the composition of the solvent absorbed by and present within the coal in the first stages of direct coal liquefaction. The scope includes the study of the conversion of Argonne Premium coals in tetralin and 2-t-butyltetralin and a comparison of the following: Conversion to soluble products and product composition. Hydrogen donated by both solvents will be measured by gas chromatography and the same technique will be used to establish the amount of dealkylation of 2-t-butyltetralin. Reactions will be performed at several different temperatures for varying amounts of time.

6032 (DOE/PC/91040–29) **Advanced direct liquefaction concepts for PETC generic units: Quarterly technical progress report, April 1993–June 1993.** Kentucky Univ., Lexington, KY (United States). Center for Applied Energy Research; Sandia National Labs., Albuquerque, NM (United States); CONSOL, Inc., Library, PA (United States); LDP Associates (United States). Aug 1993. 174p. Sponsored by USDOE, Washington, DC (United

States). DOE Contract AC22-91PC91040. Order Number DE94005040. Source: OSTI; NTIS; GPO Dep.

Section 1 contains a report of the progress by the University of Kentucky Center for Applied Energy Research on the following tasks: laboratory support (liquefaction in dewaxed and hydrotreated dewaxed solvent); CO pretreatment (effect of process variables on CO pretreatment, CO-pretreated product characterization, and liquefaction results); and iron based dispersed catalysts (production, characterization and testing of sulfated hematites and reaction model development). Section 2 contains a progress report by CONSOL, Inc. on the following tasks: laboratory support; pretreatment work on dewaxing; pretreatment work on agglomeration; and economic evaluation. Progress by Sandia National Laboratories is reported in Section 3 on the following: laboratory support (TGA methods) and solvent pretreatment (coker tar hydrogenation and coal liquefaction results). Section 4 gives a preliminary technical assessment by LDP Associates on the following: baseline economic assessment; assessment of improved coal conversion; and fluid coking.

6033 (DOE/PC/91042–6) **Effects of low-temperature catalytic pretreatments on coal structure and reactivity in liquefaction: [Quarterly] technical progress report, April–June 1993.** Song, C.; Huang, L.; Saini, A.K.; Schobert, H.H.; Hatcher, P.G. Pennsylvania State Univ., University Park, PA (United States). Dept. of Materials Science and Engineering. Jul 1993. 48p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91042. Order Number DE94003308. Source: OSTI; NTIS; GPO Dep.

In this quarter, progress has been made in the following two aspects: (1) effects of drying and mild oxidation on conversion and product distribution during non-catalytic and catalytic liquefaction of a Montana subbituminous coal (DECS-9); and (2) effects of solvent and catalyst on conversion and structural changes of a Texas subbituminous coal (DECS-1). Influence of drying and mild oxidation on catalytic and non-catalytic liquefaction (at 350C for 30 min with 6.9 MPa (cold) H_2 was studied using Wyodak subbituminous coal. For non-catalytic runs, fresh raw coal gave higher conversion and higher oil yield than both the vacuum- and air-dried coals, regardless of the solvent. Compared to the vacuum-dried coal, the coal dried in air in 100C for 2 h gave a better conversion in the presence of either a hydrogen donor tetralin or a non-donor 1-methylnaphthalene (1-MN) solvent. Catalytic runs were performed using in-situ generated molybdenum sulfide catalyst from ammonium tetrathiomolybdate (ATTM) precursor impregnated on either raw coal or predried coal samples. The solvent-free runs using ATTM loaded on the raw coal gave higher conversion and higher oil yield than loading ATTM on vacuum- or air-dried coal. In the presence of either tetralin or 1-MN, however, the runs using ATTM loaded on air-dried coal afford better conversions and oil yields as compared to the runs using vacuum-dried coal. Upon drying coal in air at 150C for 20 h, the conversion significantly decreased to a lower value than that of the vacuum-dried coal in the non-catalytic runs, and the same trend was observed in the runs of the dried coals loaded with ATTM. Physical, chemical, and surface chemical aspects of effects of drying and oxidation and the role of water are also discussed in the report.

6034 (DOE/PC/91053–T5) **Fundamental studies of coal liquefaction: Quarterly report No. 7, April 1–July 1, 1993.** Ross, D.S. SRI International, Menlo Park, CA (United States). Chemistry Lab. 14 Jul 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91053. (SRI–2847-21). Order Number DE94003304. Source: OSTI; NTIS; GPO Dep.

In our last report we discussed observations in our cell concerning the behavior or Illinois No. 6 coal in tetralin to 460°C. We noted that there were possibly two distinct type. of particles comprising the organic phase, reacting respectively at 420°–430°C, and at 450°–460°C. Alternatively we could interpret the data as describing a range of reactivity bounded by those temperatures. As evidenced by the contraction of the particles, the reactions were rapid. The particles lost half of their substance within 1 min, and we suggested that the rates were too fast to be accommodated by the commonly held scheme for coal liquefaction involving thermolytic scission of weak, bibenzyl-like bonds. Our analyses were aided by our use of Adobe Photoshop, which allows us to store, digitized versions of our recorded images. The images can then be manipulated at will to provide quantitative data on morphological changes. We noted in our last report that printer limitations prevented us from presenting images with the desirable quality, and we are at present attempting to find access to equipment which will provide satisfactory figures. Accordingly our progress will be described here without any photographs, and we expect to present a more complete account of our work in our next report. The work reported here includes studies of Illinois No. 6 coal with water as the medium, and a control run with argon as medium. Our temperature ramping was like that used last time, 25°C/min to 250°C, and then 10°C/min to 450°C. The results from the earlier work and the data presented here can therefore be directly compared.

6035 (DOE/PC/91286–T8) **The role of catalyst precursor anions in coal gasification: Eighth quarterly report, [July–September 1993].** Abotsi, G.M.K. Clark Atlanta Univ., GA (United States). Dept. of Chemistry. [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91286. Order Number DE94005047. Source: OSTI; NTIS; GPO Dep.

This project investigates the roles of various aqueous soluble catalyst precursor anions, specifically acetate, chloride, nitrate, sulfate, and carbonate anions on the surface electrical properties of coal and seeks to understand the effects of these anions on the adsorption, dispersion and activities of calcium and potassium. The effects of the various anions on coal char gasification is currently under investigation. The influence of acetate, chloride and nitrate ions, when using the corresponding potassium compounds, are discussed in this report. The thermograms for the char preparation in nitrogen show that rapid devolatilization of moisture and other volatile materials occurs in the first 30 min. The rate of weight loss decreases significantly thereafter up to about 70 min. when char preparation was complete. Introduction of carbon dioxide after this time resulted in only a small amount of carbon gasification of the unloaded, demineralized coal. However, the chars containing the acetate, chloride or nitrate of potassium gave reactivities of 24.8, 30.4 or 24.3 %wt., respectively. The catalysts were ion-exchanged with the salt solutions and the corresponding potassium content were 2.9, 2.6 and 2.3 %wt. The higher reactivities of the catalyzed chars compared to the unloaded char correlates the high degree of demineralization and the resultant low catalytic activity by the inherent inorganic materials. It is observed that the potassium acetate and the potassium nitrate have similar reactivities, while the reactivity in the presence of KCl is higher. This finding contrasts some of the previous literature reports which show that oxygen-containing catalytic salts are more active catalysts due to the formation of carbon-oxygen-metal bonds which have been postulated as pre-requisites to carbon gasification.

6036 (DOE/PC/91304–T7) **Low severity upgrading of F-T waxes with solid superacids: Quarterly report, June 1, 1993–August 31, 1993.** Tierney, J.W.; Wender, I. Pittsburgh Univ., PA (United States). Dept. of Chemical and Petroleum Engineering. [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91304. Order Number DE94004546. Source: OSTI; NTIS; GPO Dep.

During the last quarter isomerization and hydrocracking of n-hexadecane were carried out in a continuous flow fixed bed reactor described in a previous report. Test runs showed that the temperature and pressure in this reactor can be controlled to within $\pm$ 1 C and $\pm$ 2 psig, respectively. The reaction conditions were 160 C and 350 psig constant hydrogen pressure. Interestingly, product distribution from isomerization and hydrocracking of n-hexadecane conducted in this reactor is similar to that obtained from the microreactor experiments. The long-term stability of the $Pt/ZrO_2/SO_4$ catalyst was studied using this fixed bed reactor with n-hexadecane as a feedstock. Evidence was obtained that, in the presence of H_2, the $Pt/ZrO_2/SO_4$ catalyst maintains its activity for as long as 96 hours with no evidence of deactivation. The effect of addition of transition metals on the activity of ZrO_2/SO_4 was compared. Pt and Pd greatly enhanced the hydrotreating activity of ZrO_2/SO_4. The activities of $Pt/ZrO_2/SO_4$, $Pt/ZrO_2/MoO_4$ and $Pt/ZrO_2/WO_4$ catalysts were also compared; it was found that the Pt/

ZrO_2/SO_4 catalyst gave highest activity in isomerization and hydrocracking of long-chain paraffins. The authors also found that, even at high severity conditions, i.e., 300 C/600 psig and 250 C/1,200 psig, the $Pt/ZrO_2/SO_4$ catalyst is active.

6037 (DOE/PC/92108–T3) **Technology development for cobalt F-T catalysts: Quarterly technical progress report No. 1, September 25, 1992 to December 31, 1992.** Energy International Corp., Pittsburgh, PA (United States). 29 Jul 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92108. Order Number DE94004528. Source: OSTI; NTIS; GPO Dep.

The goal of this project is the development of a commercially viable, cobalt-based Fischer-Tropsch (F-T) catalyst for use in a slurry bubble column reactor. Cobalt-based catalysts have long been known as being active for F-T synthesis. They typically possess greater activity than iron-based catalysts, historically the predominant catalyst being used commercially for the conversion of syngas based on coal, but possess two disadvantages that somewhat lessen its value: (1) cobalt tends to make more methane than iron does, and (2) cobalt is less versatile with low H_2/CO ratio syngas due to its lack of water-gas shift activity. Therefore, the major objectives of this work are (1) to develop a cobalt-based F-T catalyst with low (< 5%) methane selectivity, (2) to develop a cobalt-based F-T catalyst with water-gas shift activity, and (3) to combine both these improvements into one catalyst. It will be demonstrated that these catalysts have the desired activity, selectivity, and life, and can be made reproducibly. Following this experimental work, a design and a cost estimate will be prepared for a plant to produce sufficient quantities of catalyst for scale-up studies.

6038 (DOE/PC/92527–T3) **Hindered diffusion of coal liquids: Quarterly report No. 3, March 18, 1993–June 17, 1993.** Tsotsis, T.T. (University of Southern California, Los Angeles, CA (United States). Dept. of Chemical Engineering); Sahimi, M.; Webster, I.A. University of Southern California, Los Angeles, CA (United States). Dept. of Chemical Engineering. [1993]. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92527. Order Number DE94001968. Source: OSTI; NTIS; GPO Dep.

The design of industrial catalysts requires that the diffusivity of the reacting species within the catalyst be accurately known. Nowhere is this more important than in the area of coal liquefaction and upgrading of coal liquids. In this area one is faced with the task of processing a number of heavy oils, containing metals and other contaminants, in a variety of process dependent solvents. It is important, therefore, on the basis of predicting catalyst activity, selectivity, and optimizing reactor performance, that the diffusivities of these oil species be accurately known. It is the purpose of this project to provide a correct concept of coal asphaltenes by careful and detailed investigations of asphaltene transport through porous systems under realistic process temperature and pressure conditions. The experimental studies will be coupled with detailed, in-depth statistical and molecular dynamics models intended to provide a fundamental understanding of the overall transport mechanisms.

6039 (NEDO-C–9212, pp. 73-86) **Report of investigation on coal utilization technologies in America and North Europe.** Matsukata, M. (Osaka University, Osaka (Japan). Faculty of Engineering Science). New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. (In Japanese). In *Fiscal 1992 international joint research study made by coal production/utilization technology incentive subsidies.: Survey by researchers sent overseas.* 643p. Order Number DE94732341. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

This paper is a report on investigations of the current situation in the U.S.A. and North Europe of research and development of coal utilization technologies. The U.S. EPRI presented a gasification composite power generation as a good system that can remove harmful metal contents by reducing the outlet temperature to 700°C, and has high power generation efficiency. The pressurized fluidized bed combustion (PFBC), though having been given verification tests, has a problem in removal of harmful contents, SOx and NOx emission levels, and ash removal, and is not advantageous, according to the EPRI explanation. In a PFBC/G test plant at Helsinki University of Engineering, coals, peats, and wood chips are tested as fuel. Alkali removal in gasification is experienced as a problem. A PFBC test showed a good result of the outlet SO2 concentration of 50 ppm when Ca/S ratio was 1.6. Sweden imposes a heavy tax on coal to introduce biomass in place of coal. However, an impression was felt that a contradiction has begun that lumber consumption should depend more on import because of domestic lumber cost having become higher.

6040 (ORNL/FTR–4663) **Travel to the Netherlands to attend an international workshop on Materials for Coal Gasification Power Plants: Foreign trip report, June 12–19, 1993.** DeVan, J.H. Oak Ridge National Lab., TN (United States). 8 Jul 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE93018198. Source: OSTI; NTIS (US Sales Only); GPO Dep.

A paper on laboratory corrosion tests of iron aluminides was presented at an international workshop on Materials for Coal Gasification Power Plants at Petten, the Netherlands. The three-day workshop was sponsored by the Joint Research Centre (JRC), Institute for Advanced Materials, Petten, and by the Electric Power Research Institute (EPRI), USA. It was attended by 50 participants from 6 European countries, the United States, and Japan, and provided a forum for discussing gasifier materials needs among power plant design engineers and high-temperature corrosion specialists. Following the workshop, the traveler toured a new integrated coal gasification combined cycle (ICGCC) demonstration power plant at Buggenum, the Netherlands. The 250-MW(e) plant incorporates a Shell entrained flow gasifier, converting 2000 tons of coal/day, and scheduled to begin electric generation on coal in October 1993. A visit was also made to the Shell Billiton Research Laboratory at Arnhem, the Netherlands. Discussions with laboratory representatives centered on their iron aluminide development activities, including high-temperature corrosion tests.

6041 **Split flow gasifier.** Halow, J.S. To Dept. of Energy. 1991. U.S. patent application 7-758,065. 17p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003061. Source: OSTI; NTIS; GPO Dep.

A-moving bed coal gasifier for the production of tar-free, low ammonia fuel gas is described. The gasifier employs a combustion zone in a free-aboard area above the moving bed to burn coal fines to provide hot combustion gases for pyrolyzing and gasifying coal particulates in the moving bed to form fuel gas as the hot gases move co-currently with the downwardly moving coal particulates. The fuel gas contains entrained tars and ammonia compounds which contact hot char and ash in the moving bed and are cracked so that the fuel gas removed from the gasifier at a midpoint off-take is essentially tar-free and of low ammonia content. Concurrently with this gasification reaction, steam and an oxidant are introduced into a region below the moving bed to flow countercurrently to the downwardly moving bed to contact and react with carbon remaining in the char to create additional fuel gas which is also extracted from the gasifier at the mid-point off-take.

6042 (PNL-SA–22661) **Relationship between iron oxide phase and catalytic activity in model compound reaction studies.** Darab, J.G.; Linehan, J.C.; Matson, D.W.; Campbell, J.A. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930904–13: 7. international conference on coal science, Banff (Canada), 12-17 Sep 1993). Order Number DE94002955. Source: OSTI; NTIS; GPO Dep.

Inexpensive catalysts for coal liquefaction must be developed if this process is to become economically viable. Recent emphasis has been on the use of iron-based catalysts, either in the form of nanometer-sized oxides and sulfides, or organic or water soluble compounds which have been used to impregnate the coal with dispersed iron species. In almost all cases the active form of the iron catalyst has been generated in-situ at reaction conditions in the presence of sulfur. Observation of enhanced activity with the use of sulfur and the appearance of iron-sulfides both during and after the liquefaction reactions have led to the suggestion that an

iron-sulfide is the catalytically active species. In this study we investigated the effect of iron-oxyhydroxide catalyst precursor phase on the bond scission ability of the catalysts produced in-situ in the presence of sulfur with the model compounds naphthyl bibenzylmethane (NBBM), bibenzyl (BB), diphenylmethane (DPM) and dibenzothiophene (DBT). The catalyst precursors investigated were ferric oxyhydroxysulfate (OHS), goethite (α-FeOOH), akaganeite (β-FeOOH) and six-line ferrihydrite. These precursors were chosen for their enhanced activity for carbon-carbon bond scission with NBBM over other iron-oxyhydroxides and iron-oxides. The reactions of these catalyst precursors with the model compounds were investigated both with and without a hydrogen-donating solvent.

6043 (PNL-SA–22667) **Analysis of the radical hydrogen transfer pathway for cleaving strong bonds in coal.** Autrey, S.T.; Camaioni, D.M.; Ferris, K.F.; Franz, J.A. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930904–14: 7. international conference on coal science, Banff (Canada), 12-17 Sep 1993). Order Number DE94002953. Source: OSTI; NTIS; GPO Dep.

Hydrogen transfer processes involving radical intermediates are of key importance in the liquefaction of coal. While the primary function of donor solvents is to transfer H• to coal-derived radicals that form when weak bonds are cleaved thermolytically, growing evidence suggests that the donor solvent can play a role in promoting cleavage of strong α-bonds. McMillen and Malhotra have explained the results in terms of a single-step mechanism referred to as radical H-transfer (RHT). Mechanistic kinetic models have been used to suggest the importance of RHT pathways in anthracene- and pyrene-based solvent systems. However, we question the reliability of these approaches because little experimental data exists to support the 16.5 kcal/mol intrinsic barriers they assume for RHT reactions. Unambiguous evidence for RHT is very difficult to obtain experimentally because at the temperatures required to activate the RHT reaction, a suite of multistep reactions can occur, which yield the same products, i.e. H-elimination from hydroaryl radicals followed by ipso addition. For this reason, we have sought to gain insight to barrier heights for RHT from theory. This paper reports our use of Marcus theory in combination with ab initio and semiempirical molecular orbital methods to show how the intrinsic barriers for RHT reactions depend on structural and thermodynamic properties of the reacting partners. In addition, reactions thought to be mediated by RHT are reexamined using mechanistic kinetic modeling (MKM) to determine the extent to which these reactions can be explained by conventional pathways.

6044 (SAND–93-1802C) **Activity testing of fine-particle size, iron catalysts for coal liquefaction.** Stohl, F.V.; Diegert, K.V.; Gugliotta, T.P. Sandia National Labs., Albuquerque, NM (United States). [1993]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. (CONF-9309257–1: Coal liquefaction and gas conversion contractor's review conference, Pittsburgh, PA (United States), 27-29 Sep 1993). Order Number DE94001212. Source: OSTI; NTIS; GPO Dep.

The use of fine-particle size (< 40 nm) unsupported catalysts in direct coal liquefaction may result in improved economics due to possible enhanced yields of desired products, the potential for decreasing reaction severity, and the possibility of using less catalyst. Sandia has developed a standard testing procedure for evaluating and comparing the fine-particle catalysts. The test procedure uses phenanthrene as the reaction solvent, the DECS-17 Blind Canyon Coal, and a statistical experimental design to enable evaluation of the catalysts over ranges of temperature (350 to 400°C), time (20 to 60 minutes), and catalyst loading (0 to 1 wt % on a dmmf coal basis). Product analyses include tetrahydrofuran (THF) conversion, heptane conversion, solvent recovery, and gas analyses. Phenanthrene as the solvent in the testing procedure yielded significant differences between thermal and catalytic reactions, whereas using a good hydrogen donor such as 9,10-dihydrophenanthrene (DHP) showed no catalytic effects.

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Refer also to citation(s) 6011, 6012, 6043, 6060

6045 (DOE/MC/11076–3554) **Solid-state NMR analysis of coals and shales from the Mesaverde Group, Green River Basin, Wyoming.** Miknis, F.P.; MacGowan, D.B. University of Wyoming Research Corp., Laramie, WY (United States). Western Research Inst. Aug 1993. 29p. Sponsored by USDOE, Washington, DC (United States);Gas Research Inst., Chicago, IL (United States). DOE Contract FC21-86MC11076 ; FG05-89ER75506. 5091-221-2146. Order Number DE94000079. Source: OSTI; NTIS; GPO Dep.

Samples of coals and shales from the Almond Formation of the Mesaverde Group, Greater Green River Basin, Wyoming were analyzed using solid-state ^{13}C nuclear magnetic resonance (NMR) techniques of cross polarization with magic-angle spinning (CP/MAS). The samples were taken from a present-day depth of burial ranging from ~3,000 to ~15,000 ft. In addition, CP/MAS ^{13}C NMR measurements were made on residues from the hydrous pyrolysis of Almond coal. The hydrous pyrolysis experiments were conducted isothermally for 72 hr in the temperature range of 290 to 360°C (554 to 680°F). In general, the maturation trends observed by NMR for the naturally and artificially matured samples were in agreement with results obtained from other geochemical analyses. The NMR spectra of the naturally matured shale samples showed only a small aliphatic component at depths greater than about 12,000 ft, indicating little capacity for hydrocarbon generation at depths greater than this. Vitrinite reflectance measurements placed the oil window at between 4,500 and 14,500 ft. NMR measurements of the hydrous pyrolysis residues showed a clear loss of aliphatic carbon, relative to the aromatic carbon, with temperature. For the residue obtained from the highest study temperature (360°C/680°F), there was a 60% depletion of the hydrocarbon-producing aliphatic components. The trends in loss of aliphatic carbon with temperature suggested a means of defining a geochemical transformation ratio in terms of the loss of the aliphatic carbon fraction. A good correlation was found between the NMR transformation ratio and the production index determined by Rock-Eval pyrolysis measurements.

6046 (DOE/MC/30098–3552) **Multiple-use marketing of lignite.** Knudson, C.L. North Dakota Univ., Grand Forks, ND (United States). Energy and Environmental Research Center. Sep 1993. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-93MC30098. Order Number DE94000077. Source: OSTI; NTIS; GPO Dep.

Marketing of lignite faces difficulties due to moisture and sulfur contents, as well as the sodium content, of the ash. The purpose of this study is to determine the economic viability of multiple-use marketing of lignite as a method to increase the use of North Dakota lignite by recapturing lost niche markets. Multiple-use marketing means using lignite and sulfur-capturing additives to clean agricultural wastewater followed by either direct steam and power generation or briquetting to produce a higher-Btu compliance fuel. Cooperative ownership of the resulting business by a coal company and an agriculture processing company helps ensure that lignite remains the coal of choice, especially when the "good" attributes of lignites are maximized, while the agricultural company obtains cleaner wastewater and a long-term supply of coal at a set price. The economic viabilities of the following scenarios were investigated: (1) Agriprocessing wastewater treatment using lignite and an additive followed by (2) the production of compliance fuel for resale or on-site cogeneration of steam and electricity. Laboratory tests were performed utilizing potato-processing plant wastewater with lignite and lime sludge.

6047 (DOE/PC/89663–T10) **Development of a Coal Quality Expert: Final technical progress report No. 12, [January 1–March 31, 1993].** CQ, Inc., Homer City, PA (United States). 12 Aug 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89663. Order Number DE94003598. Source: OSTI; NTIS; GPO Dep.

During the past quarter, Tasks 3, 4, 5, and 6 were active. Task 3 Pilot Scale Combustion Testing activity included data analysis of

pilot- and bench-scale combustion samples in support of the development of CQE slogging and fouling models. Under Task 4, field testing at the fifth host utility site – New England Power Service Company's Brayton Point Unit 3 – was completed in March with the testing of the alternate coal. Test plans were finalized for the sixth and final field test to be performed at Brayton Point Unit 2 in April 1993. Tasks 5 and 6 activities were directed at design and development of CQE base classes and objects, continued formulation and integration of CQE algorithms and submodels, development of the user interface prototype, and preparation of the Fireside Advisor.

6048 (DOE/PC/89883–76) **Coal liquefaction process streams characterization and evaluation: Quarterly technical progress report, October 1–December 31, 1992.** Brandes, S.D.; Winschel, R.A.; Burke, F.P.; Robbins, G.A. CONSOL, Inc., Library, PA (United States). Research and Development Dept. Oct 1993. 67p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-89PC89883. Order Number DE94005042. Source: OSTI; NTIS; GPO Dep.

The Research and Development Department of CONSOL Inc. is conducted a program to characterize process and product streams from direct coal liquefaction process development projects sponsored by the Department of Energy. In this program, CONSOL obtains samples from current process development activities in coal liquefaction and coal-oil coprocessing, and characterizes them using established analytical techniques. In addition, selected samples are characterized by other analytical techniques to evaluate their potential for aiding process development. These analyses and interpretation of the results in relation to process operations are provided by the subcontractor. Major topics reported in this thirteenth quarterly report are the following: (1) Analyses were performed on three coals and eleven process oils from HRI, Inc. process development unit Run 260–03, which was the first process development unit test of Black Thunder Mine subbituminous coal, significant operating problems were encountered, and sample properties are discussed in context to the operational problems; (2) a summary of the status of the Participants Program is given; (3) summaries of the final reports produced by the University of Chicago, the University of Utah, Iowa State University, and the University of Kentucky under the Participants Program, are presented.

6049 (DOE/PC/89883–78) **Coal liquefaction process streams characterization and evaluation: Quarterly technical progress report, April 1–June 30, 1993.** Brandes, S.D.; Winschel, R.A.; Burke, F.P.; Robbins, G.A. CONSOL, Inc., Library, PA (United States). Research and Development Dept. Nov 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-89PC89883. Order Number DE94005041. Source: OSTI; NTIS; GPO Dep.

The Research and Development Department of CONSOL Inc. (CONSOL) is conducting a program to characterize process and product streams from direct coal liquefaction process development projects sponsored by the Department of Energy. In this program, CONSOL obtains samples from current process development activities in coal liquefaction and coal-oil coprocessing, and characterizes them using established analytical techniques. In addition, selected samples are characterized by other analytical techniques to evaluate their potential for aiding process development. These analyses and interpretation of the results in relation to process operations are provided by the subcontractor. Major topics reported in this fifteenth quarterly report are the following: (1) the status of the Participants Program is described, trips were made to The Pennsylvania State University and the University of Delaware for the purpose of establishing teaming arrangements, the trip reports are appended; (2) a description of work in progress in included, (3) two papers are appended. One of these papers describes work performed under subcontract in Phase 1 of the Participants Program by the University of Kentucky Center for Applied Energy Research. The second paper describes stable carbon isotope analysis of coprocessing materials. Both papers were accepted for publication in Fuel.

6050 (DOE/PC/90290–12) **Advanced NMR approaches in the characterization of coal: [Quarterly] report No. 12, [April–June 1993].** Maciel, G.E. Colorado State Univ., Fort Collins, CO (United States). Dept. of Chemistry. [1993]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-90PC90290. Order Number DE94002670. Source: OSTI; NTIS; GPO Dep.

Short communication. COAL/nuclear magnetic resonance; COAL; CARBON 13; HYDROGEN 1; SPECTROSCOPY; PROGRESS REPORT

6051 (DOE/PC/90290–13) **Advanced NMR approaches in the characterization of coal: Final technical report, September 1, 1990–August 31, 1993.** Maciel, G.E. Colorado State Univ., Fort Collins, CO (United States). 30 Sep 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-90PC90290. Order Number DE94003521. Source: OSTI; NTIS; GPO Dep.

This project addressed two main goals and one much smaller one. The main goals were (1) to improve the significance, reliability and information content in high-resolution NMR (nuclear magnetic resonance) characterization of coal samples and (2) to develop chemically informative NMR imaging techniques for coal. The minor goal was to explore advanced features of dynamic nuclear polarization (DNP) as a technique for coal characterization; this included the development of two DNP probes and the examination of DNP characteristics of various carbonaceous samples, including coals. ^{13}C NMR advances for coal depended on large-sample MAS devices, employing either cross-polarization (CP) or direct polarization (DP) approaches. CP and DP spin dynamics and their relationships to quantitation and spin counting were elucidated. ^{1}H NMR studies, based on CRAMPS, dipolar dephasing and saturation with perdeuteropyridine, led to a ^{1}H NMR-based elucidation of chemical functionality in coal. ^{1}H and ^{13}C NMR imaging techniques, based on magic-angle spinning and rotating magnetic field gradients, were developed for introducing chemical shift information (hence, chemical detail) into the spatial imaging of coal. The TREV multiple-pulse sequence was found to be useful in the ^{1}H CRAMPS imaging of samples like coal.

6052 (DOE/PC/91305–8) **Characterization of porosity via secondary reactions: Quarterly technical progress report, 1 July 1993–30 September 1993.** Calo, J.M.; Zhang, L. Brown Univ., Providence, RI (United States). Div. of Engineering. [1993]. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91305. Order Number DE94005043. Source: OSTI; NTIS; GPO Dep.

Specific surface area is of paramount importance for all heterogeneous interactions occurring at coal char surfaces. Accessibility of this surface area is governed by the pore structure morphology of the char, which varies over a considerable range and which is determined by a large number of factors including the nature of the porosity prior to carbonization, the carbonization process, and extent and method of any subsequent activation or gasification. A persistent problem in this area has been the reliable, quantitative measurement of the resultant porosity, especially the micropores. The current project is directed at the development of a new approach to this very old problem. During the course of recent work applying temperature programmed desorption (TPD) to the determination of energetic distributions of oxygen complexes on the surfaces of oxidized coal chars, the authors discovered that secondary interactions occurring within the char structure during TPD produce characteristic features that appear to be quite sensitive to char porosity. The relative and absolute extents of these secondary interactions form the basis of a potential characterization technique. Here the authors report on the progress that has been made in the construction, development and testing of a new TPD-MS/TGA system being developed in their laboratory. The project plan also includes the use of other techniques to characterize porosity for the purposes of comparison, quantification, and validation. It is noted that at least two other more well established methods will be used in such a manner: specifically, gas adsorption techniques and small angle scattering.

6053 (DOE/PC/92544–5) **Vapor pressures and heats of vaporization of primary coal tars: Quarterly technical progress report, 1 July 1993–30 September 1993.** Suuberg, E.M. Brown Univ., Providence, RI (United States). Div. of Engineering. [1993]. 31p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract FG22-92PC92544. Order Number DE94005023. Source: OSTI; NTIS; GPO Dep.

There is significant current interest in general area of coal pyrolysis, particularly with respect to comprehensive models of this complicated phenomenon. This interest derives from the central role of pyrolysis in all thermally driven coal conversion processes – gasification, combustion, liquefaction, mild gasification, or thermal benefication. There remain several key data needs in these application areas. Among them is a need for more reliable correlation for prediction of vapor pressure of heavy, primary coal tars. Such information is important in design of all coal conversion processes, in which the volatility of tarry products is of major concern. Only very limited correlations exist, and these are not considered reliable to even an order of magnitude when applied to tars. The present project seeks to address this important gap in the near term by direct measurement of vapor pressures of coal tar fractions, by application of well-established techniques and modifications thereof. The principal objectives of the program are to: (1) obtain data on the vapor pressures and heats of vaporization of tars from a range of ranks of coal, (2) develop correlations based on a minimum set of conveniently measurable characteristics of the tars, (3) develop equipment that would allow performing such measurements in a reliable, straightforward fashion. Results of the literature survey are compiled. The experimental tasks have been concerned with setup and calibration.

6054 (NEDO-C–9212, pp. 10-50) **Report of investigation on current situation of fundamental studies on coal in Spain.** Makino, M. (National Institute for Resources and Environment, Tsukuba (Japan)). New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. (In Japanese). In *Fiscal 1992 international joint research study made by coal production/utilization technology incentive subsidies.: Survey by researchers sent overseas.* 643p. Order Number DE94732341. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

This paper is a report on the investigation in Spain of fundamental studies on coals rich in ash, sulfur, and moisture. Grain sizes of limestones used for fluidized bed combustion of coals were measured using a mercury porosimeter. The measurement identified difference in grain size distribution among limestones from Blanca, Maria and Sastago. It was shown that the maximum invert ratio and the reaction rate of desulfurizing agents become larger when the faster the heating rate in calcination, and the smaller the grain size. Their maximum values in relation with temperatures appeared at from 800°C to 900°C. Ash flow-out in a fluidized bed experiment at 850°C was 21% to 28% of ash contained in the original coal, while sulfur captured in the ash was 58% to 73% of sulfur in the coal, and calcium in the ash reached 70% to 90% of that in the original coal. Coarse ash with a grain size of 1.3 mm contained sulfur at as little as 0.2%, but ash of 63 micron size contained 4% of sulfur. 22 figs., 17 tabs.

6055 Apparatus for preventing particle deposition from process streams on optical access windows. Logan, R.G.; Grimm, U. To Dept. of Energy. 1991. U.S. patent application 7-779,473. 15p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003039. Source: OSTI; NTIS; GPO Dep.

This invention is comprised of an electrostatic precipitator that is disposed inside and around the periphery of the window of a viewing port communicating with a housing through which a particle-laden gas stream is being passed. The precipitator includes a pair of electrodes around the periphery of the window, spaced apart and connected to a unidirectional voltage source. Application of high voltage from the source to the electrodes causes air molecules in the gas stream to become ionized, attaching to solid particles and causing them to be deposited on a collector electrode. This prevents the particles from being deposited on the window and keeps the window clean for viewing and making optical measurements.

0108 Waste Management

Refer also to citation(s) 6065, 6584, 6586, 6587, 6591

6056 (DOE/PC/89658–T6) **Innovative coke oven gas cleaning system for retrofit applications: Quarterly technical progress report No. 4, October 1, 1990 to December 31, 1990.** Kwasnoski, D. Bethlehem Steel Corp., PA (United States). 22 Oct 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89658. Order Number DE94004516. Source: OSTI; NTIS; GPO Dep.

Work on this coke oven gas cleaning demonstration project (CCT-II) this quarter has been focused on Phase IIB tasks, and include engineering, procurement, construction, and training. Additionally, plans for changes in the operating schedule of the coke plant that affect the demonstration project are described. Engineering efforts are nearly complete. Remaining to be finalized is an assessment of electrical heat tracing/insulation needs for pipe lines, assessment of fire protection requirements, and instrument modifications. Procurement of all major equipment items is complete, except for possible additions to fire fighting capabilities. Major focus is on expediting pipe and structural steel to the project site. Civil construction is complete except for minor pads and bases as required for pipe supports, etc. Erection of the hydrogen sulfide and ammonia scrubber vessels is complete. Installation of scrubber vessel internals is underway. A subcontractor has been retained to develop a computerized program for operations and maintenance training for the coke oven gas treatment plant. Recent developments in the coke plant operating plans will result in reductions in the rate of production of coke oven gas to be processed in the demonstration project.

6057 (DOE/PC/90299–T12) **Improved utilization of coal derived fly ash in concrete: Quarterly technical progress report No. 12.** Liskowitz, J.W.; Cerkanowicz, A.E.; Wecharatana, M. New Jersey Inst. of Tech., Newark, NJ (United States). Dept. of Civil Engineeering. [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-90PC90299. Order Number DE94005044. Source: OSTI; NTIS; GPO Dep.

Successful use of coal derived fly-ash in the formulation of concrete currently depends on long term testing of the suitability of sample ash-concrete formulations prior to ash acceptance. Existing tests have proven unreliable and have not provided correlation between formulated concrete strength and fly-ash/combustor/coal properties or characteristics. This program represents a study of the interrelationship between the ash formation processes, the ash properties, and the concrete quality. Given the coal type used and the conditions under which the combustion and ash collection was carried out, the authors expect to predict the optimum use of the captured ash in concrete formulation. Further, they intend to utilize these results to develop an innovative ash quality test.

6058 (DOE/PC/90546–T9) **Confined zone dispersion flue gas desulfurization demonstration: Quarterly report No. 8, August 17, 1992–November 16, 1992.** Bechtel Corp., San Francisco, CA (United States). 27 Sep 1993. 254p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-91PC90546. Order Number DE94002404. Source: OSTI; NTIS; GPO Dep.

The CZD process involves injecting a finely atomized slurry of reactive lime into the flue gas duct work of a coal-fired utility boiler. The principle of the confined zone is to form a wet zone of slurry droplets in the middle of the duct confined in an envelope of hot gas between the wet zone and the duct walls. The lime slurry reacts with part of the SO_2 in the gas, and the reaction products dry to form solid particles. A solids collector, typically an electrostatic precipitator (ESP) downstream from the point of injection, captures the reaction products along with the fly ash entrained in the flue gas. The goal of this demonstration is to prove the technical and economic feasibility of the CZD technology on a commercial scale. The process is expected to achieve 50% SO_2 removal at lower capital and O&M costs than other systems. To achieve its objectives, the project is divided into the following three phases: Phase 1: Design and Permitting, Phase 2: Construction and Start-up, Phase 3: Operation and Disposition. Phase 1 activities were completed on January 31, 1991. Phase 2 activities were essentially concluded on July 31, 1991, and Phase 3a, Parametric Testing,

was initiated on July 1, 1991. This Quarterly Technical Progress Report covers Phase 3b activities from August 17, 1992 through November 16, 1992.

6059 (NUTEK–91-51917) **Catalytic reduction of NO_x.** Odenbrand, I. (Lund Inst. of Tech. (Sweden). Dept. of Chemical Engineering). Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden); Lund Univ. (Sweden). Dept. of Chemical Engineering. Sep 1992. 16p. (In Swedish). Order Number DE94730412. Source: OSTI; NTIS.

The selectivity towards nitrogen has been studied with the aim of reducing the amounts of nitrous oxide formed as a by product in the SCR-process. The results show that addition of small amounts of water vapour has a very beneficial effect on decreasing the nitrous oxide formation to very low values at normal SCR conditions (below 400 deg C). At high temperatures the effect is smaller. The formation of nitrous oxide is reduced anyway, by new reactions, at temperatures above 450 deg C. A study on different crystalline vanadia oxides has shown that V_2O_5 is the most stable phase during the reaction. V_6O_{13} is not stable but is rapidly oxidised to V_2O_5. $V_2O_4(VO_2)$ on the other hand is comparatively stable. A change in structure is observed when the reaction is carried out at 400 deg C. Simultaneously the selectivity for nitrogen increases. This is preferentially caused by depressing of direct ammonia oxidation reactions taking place on specific crystalline planes in V_2O_4. The support material used, SiO_2-TiO_2, has been characterized using XRD, ESCA, FTIR and adsorption measurements. The effect of promoters, Fe and Cu, on a V_2O_5/SiO_2-catalyst has been studied. It was possible to determine the content of V(IV) in the catalyst under working conditions and its effect on the activity of the catalyst. Poisoning by SO_2 caused a lowering of the amount of V(IV) present in the active phase. A certain amount of V(IV) was found to be beneficial to the catalyst activity. Sintering of the active material and the support can cause problems in applications using temperatures above 500 deg C. The use of sepiolite, as a catalyst material, has been investigated. A kinetic study showed that a Langmuir-Hinshelwood rate expression fits the experimental data quite nicely. 13 refs, 2 figs, 2 tabs

0109 Environmental Aspects

Refer also to citation(s) 6078

6060 (ECN-C–93-064) **Classification of pulverized coal ash: Part 2: Leaching properties of concrete with pulverized coal fly ash as partial cement replacement.** Van der Sloot, H.A.; De Groot, G.J.; Hoede, D. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Nov 1993. 73p. Contract NOVEM 20.53-021.10. Order Number DE94729857. Source: OSTI; NTIS; INIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

In part 1 the leaching behavior of pulverized coal ash is dealt with. addressing leachability as a function of the liquid-to-solid ratio and as a function of pH. In this report the leaching behavior of cement-based products, containing pulverized coal ash is described. The utilization of pulverized coal fly ash as an admixture in cement has been prompted by the beneficial properties of coal fly ash. The coal fly ash can be used in the clinker production and as a partial cement replacement due to its pozzolanic properties. As a result of discussions on the environmental effects of coal ash utilization the leaching properties of cement mortars containing coal fly ash were studied in a previous study. The actual cement concrete tubes containing cement, sand, coal fly ash, gravel and water were tested for their leachability, using a standardized leach testing procedure. The test is based on the assessment of intrinsic leaching properties. The results are compared with data obtained from another study on pure cement/coal fly ash/sand mortars. In addition the results from a study on a size-reduced cement/fly ash mortar are given as a function of liquid-to-solid ratio and contact time. The information gained from that study is relevant to assess the potential long-term effects after complete deterioration of the cement-based matrix and the influence of particle size on leaching. Based on the intrinsic information obtained in these studies, estimates are given for the long-term release of trace contaminants from coal fly ash in concrete applications. 21 figs., 18 tabs., 5 appendices, 30 refs.

6061 (NEI-SE–126) **Final report on dust monitoring near Kellingley coal mine, North Yorkshire.** Vallack, H.W. (Stockholm Environment Inst. at York, Univ. of York (United Kingdom)). Stockholm Environment Inst. (Sweden). Jun 1992. 5p. Order Number DE94730416. Source: OSTI; NTIS; INIS.

Dust deposition was monitored at a residential location near Kellingley Coal Mine over two four-weekly periods (November/December 1991 and March/April 1992) using a wet Frisbee dust deposit gauge. The mean rates of dust deposition for both periods (696.4 and 415.5 mg m^{-2} day^{-1} respectively) were well in excess of a proposed acceptable upper limit (195 mg m^{-2} day^{-1}) for residential conditions. Mean estimated coal dust content during both periods (80.9 and 49.7 per cent) was also high. It is concluded that coal dust from Kellingley Coal Mine gave rise to excessively high levels of dust deposition at the monitoring site, especially during the first four-weekly period. The situation would appear to have deteriorated since a similar monitoring exercise was carried out in 1989. 4 refs, 2 figs, 2 tabs

0130 Transport, Handling, and Storage

Refer also to citation(s) 6819

6062 (DOE/PC/90182–T11) **Studies of granular flow down an inclined chute: Quarterly technical progress report, Year Three, Quarter Three, 13 June 1993–12 September 1993.** Hanes, D.M. Florida Univ., Gainesville, FL (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90182. Order Number DE94005033. Source: OSTI; NTIS; GPO Dep.

The dynamics of flowing granular material has been previously observed in inclined chutes. One of the questions arising from previous work regards the existence of fully developed, steady flows. Depending upon the friction or bumpiness of the chute base, experiments have indicated that under some conditions the flow appears to be steady and fully developed. While a truly fully developed flow can never be proven to exist in an experimental apparatus because of its finite length, apparent fully developed flows are observed to within reasonable experimental accuracy. The present series of experimental focuses on the existence of steady, fully developed flows over a low friction, bumpy base.

6063 (DOE/PC/91297–T3) **A computational model for coal transport and combustion: Quarterly technical progress report, June 1, 1993–August 31, 1993.** Ahmadi, G. Clarkson Univ., Potsdam, NY (United States). Dept. of Mechanical and Aeronautical Engineering. [1993]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91297. Order Number DE94005046. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to develop an accurate model describing turbulent flows of coal slurries, rapid flows of granular coal-air mixtures, and turbulent coal combustion processes. The other main objective is to develop a computer code incorporating the new model. Experimental verification of the foundation of the model is also included in the study. In this report the thermodynamically consistent, rate dependent model for turbulent two-phase flows analysis was used and the phasic fluctuation energy dissipation rates are evaluated. Further progress on the application of the kinetic model for rapid flows of granular materials including the frictional energy losses were made. The velocity, the fluctuation energy and the solid volume fraction profiles for granular flows down a vertical channel were obtained. The results were compared with the molecular dynamic simulations of Savage and good agreement was obtained. The computational model was used and the rapid granular flows around a rectangular block in a channel were analyzed. The effect of bumpy wall on flow of granular materials was analyzed. The special case of Couette flow was studied. The preliminary results obtained is quite encouraging. Further progress was made in the experimental study of mono-layer simple shear flow device. Preliminary data concerning the shearing of 12 mm multi-color glass particles are obtained.

0140 Combustion

Refer also to citation(s) 6039, 6046, 6054, 6063, 6412, 6420, 6569, 6570, 6586, 6913

6064 (DOE/CH/10093–194) **Industrial innovations for tomorrow: Advances in industrial energy-efficiency technologies: Commercial power plant tests blend of refuse-derived fuel and coal to generate electricity.** National Renewable Energy Lab., Golden, CO (United States); Energetics, Inc., Columbia, MD (United States). Nov 1993. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE93000059. Source: OSTI; NTIS; GPO Dep.

MSW can be converted to energy in two ways. One involves the direct burning of MSW to produce steam and electricity. The second converts MSW into refuse-derived fuel (RDF) by reducing the size of the MSW and separating metals, glass, and other inorganic materials. RDF can be densified or mixed with binders to form fuel pellets. As part of a program sponsored by DOE's Office of Industrial Technologies, the National Renewable Energy Laboratory participated in a cooperative research and development agreement to examine combustion of binder-enhanced, densified refuse-derived fuel (b-d RDF) pellets with coal. Pelletized b-d RDF has been burned in coal combustors, but only in quantities of less than 3% in large utility systems. The DOE project involved the use of b-d RDF in quantities up to 20%. A major goal was to quantify the pollutants released during combustion and measure combustion performance.

6065 (DOE/FTR–94004045) **Travel to China for the World Congress on Engineering and the Environment III and the Second Asian-Pacific International Symposium on Combustion and Energy Utilization: Foreign trip report, October 8–24, 1993.** Ekmann, J.M. USDOE Pittsburgh Energy Technology Center, PA (United States). [1993]. 19p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004045. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The World Congress on Engineering and the Environment III and the Second Asian-Pacific International Symposium on Combustion and Energy Utilization were held back-to-back in Beijing, P.R. China, from October 11–18, 1993. Mr. James Ekmann attended representing the Pittsburgh Energy Technology Center and Fossil Energy. Mr. Ekmann is a member of the International Organizing Committee for the Second Asian-Pacific International Symposium on Combustion and Energy Utilization, and presented papers at both meetings. In addition, Mr. Ekmann had been invited to visit several institutes in the cities of Xian and Taiyuan. The two symposia provided a unique opportunity for Pittsburgh Energy Technology Center scientists (1) to hear unpublished accounts of current, on-going research into coal combustion and pollutant control from scientists in many countries (2) to discuss current research privately with these same scientists and other researchers from the organizations visited, and (3) to increase awareness in the international energy and environmental research community of technologies and associated products from the United States that are available for export.

6066 (DOE/MC/23174–3490) **Characterization of coal-water slurry fuel sprays from diesel engine injectors.** Caton, J.A.; Kihm, K.D. Texas A and M Univ., College Station, TX (United States). Dept. of Mechanical Engineering. Jun 1993. 83p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-88MC23174. Order Number DE94000023. Source: OSTI; NTIS; GPO Dep.

Experiments were conducted to characterize coal-water slurry fuel sprays from diesel engine injectors. Since the combustion event is a strong function of the fuel spray, full characterization of the spray is a necessity for successful engine design and for modeling of the combustion process. Two experimental facilities were used at TAMU to study the injection of coal slurry fuels. The first experimental facility incorporates General Electric locomotive engine components (injection pump, fuel line, and nozzle) and a specially designed diaphragm to separate the abrasive coal slurry fuel from the moving parts of the pump. The second experimental facility is based on an accumulator injector from General Electric. Instrumentation includes instantaneous needle lift and fuel line pressure. A pressurized visualization chamber was used to provide a spray environment which simulated the engine gas density and permitted the use of spray diagnostic techniques. The study was divided into two phases: (1) overall characterization of the spray, and (2) detailed droplet size and size distribution characterization. In addition to this overall characterization of the spray, the second phase of this study characterized the details of the atomization quality.

6067 (DOE/METC–93/6131) **Proceedings of the coal-fired power systems 93: Advances in IGCC and PFBC review meeting.** Bonk, D.L. (ed.). USDOE Morgantown Energy Technology Center, WV (United States). Jun 1993. 582p. Sponsored by USDOE, Washington, DC (United States). (CONF-9306148–: Coal-fired power systems '93: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 28-30 Jun 1993). Order Number DE93000289. Source: OSTI; NTIS; GPO Dep.

Coal is and will continue to be the cornerstone of the written or actual energy policies of both the US and many other countries. This report contains brief descriptions of projects that will influence current and future policies. This presentation will discuss how this can be accomplished using Clean Air Implementation and Global Climate Change concerns as examples. Separate abstracts were prepared for each presentation of this report.

6068 (DOE/METC/C–93/7101) **Effects of particle properties on fluidization characteristics of coarse particles.** Mei, J.S. (USDOE Morgantown Energy Technology Center, WV (United States)); Rockey, J.M.; Robey, E.H. USDOE Morgantown Energy Technology Center, WV (United States). [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). (CONF-9308193–1: 4. international conference on circulating fluidized beds, Champion, PA (United States), 1-5 Aug 1993). Order Number DE94003921. Source: OSTI; NTIS; GPO Dep.

Fluidized-bed reactors can be operated in different flow regimes. Since the gas-solid contacting modes vary as the fluidization regimes change, results obtained from one flow regime for a particulate material can not be applied to another (Grace, 1986). Ascertaining flow regimes of operation is, therefore, essential for design and scaleup of fluidized-bed reactors as well as for reactor performance predictions. During the past decades, considerable research efforts have been spent on flow regime studies for fine particles (Geldart's group A and group B powder). Most of the available data has been obtained with small laboratory-scale units of 15 cm diameter or less. Most fossil energy fluidized bed combustors have used coarse particles as bed material for economic reasons. For example, both bubbling and circulating fluidized bed combustion systems have used coarse coal and limestone particles. It is the objective of this study to better understand the various flow regimes and their transitions from: incipient fluidization to high velocity fluidization using coarse particles in a 30 cm diameter atmospheric fluidized bed cold model. Results of this investigation on high velocity fluidization process will be helpful in predicting operational characteristics and improving circulating fluidized-bed reactor design and scale up for fossil energy applications.

6069 (DOE/METC/C–94/7104) **METC Combustion Research Facility.** Halow, J.S.; Maloney, D.J.; Richards, G.A. USDOE Morgantown Energy Technology Center, WV (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). (CONF-930893–30: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94002977. Source: OSTI; NTIS; GPO Dep.

The objective of the Morgantown Energy Technology Center (METC) high pressure combustion facility is to provide a mid-scale facility for combustion and cleanup research to support DOE's advanced gas turbine, pressurized, fluidized-bed combustion, and hot gas cleanup programs. The facility is intended to fill a gap between lab scale facilities typical of universities and large scale combustion/turbine test facilities typical of turbine manufacturers. The facility is now available to industry and university partners through cooperative programs with METC. High pressure combustion research is also important to other DOE programs. Integrated gasification combined cycle (IGCC) systems and second-generation, pressurized, fluidized-bed combustion (PFBC) systems use gas turbines/electric generators as primary power generators. The turbine combustors

play an important role in achieving high efficiency and low emissions in these novel systems. These systems use a coal-derived fuel gas as fuel for the turbine combustor. The METC facility is designed to support coal fuel gas-fired combustors as well as the natural gas fired combustor used in the advanced turbine program.

6070 (DOE/PC/90285–T10) **Synergistic capture mechanisms for alkali and sulphur species from combustion: Quarterly report No. 11, March 1993–May 1993.** Peterson, T.W.; Shadman, F.; Wendt, J.O.L.; Wu, Baochun. Arizona Univ., Tucson, AZ (United States). Dept. of Chemical Engineering. 26 Jul 1993. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-90PC90285. Order Number DE94001980. Source: OSTI; NTIS; GPO Dep.

Sulfur dioxide is one of the major pollutant from coal combustion application and gasification. The capture of sulfur from flue gas with lime has been investigated and proven to be effective. Previous work concluded that the overall conversion of lime is limited by the micro-structure of the particles and reaction temperature. Due to the larger specific volume of product of calcium sulfate than that of the raw sorbent of calcium carbonate, which may cause pore blockage at the pore mouth and increase the diffusion resistance of sulfur dioxide through the product layer, but this pore plugging will not apply to the particle less than 0.01 cm in diameter. The reaction temperature, which determined the chemical reaction kinetics, between 800°C to 850°C, is recommended to be the best chemical reaction temperature for sulfur removal by lime. The alkali vapor removal has been the subject of many studies due to the possible application of coal combustion and hot flue gas turbine combined cycle which requires alkali concentration in the flue gas phase of sub parts per billion (ppB) level. But this process will increase the coal utilization efficiency dramatically. Some clay materials such as kaolinite and alumina-silica mixture like bauxite are found to be a very good sorbent for the adsorption of alkali vapor. The main objective of this research is to develop sorbents with alumina-silica base for both as a carrier to calcium and sorbents to alkali. A number of sorbents, with bauxite based and calcium active sites, have been developed and tested in a series of experiments. The experimental results of adsorption of sulfur dioxide, alkali and combined adsorption of sulfur/alkali have been given in the previous report.

6071 (DOE/PC/90310–T13) **Combustion of dense streams of coal particles: Quarterly progress report No. 12, May 29, 1993–August 28, 1993.** Annamalai, K. Texas A and M Univ., College Station, TX (United States). Dept. of Mechanical Engineering. 20 Sep 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-90PC90310. Order Number DE94002656. Source: OSTI; NTIS; GPO Dep.

Research continued on coal stream combustion. This report presents the results obtained from the gasification efficiency experiments by varying the (i) air fuel ratio of the coal cloud (ii) reaction zone height (residence time) and (iii) oxygen concentration. A brief discussion on the divergence of coal stream is presented.

6072 (DOE/PC/91308–7) **Particulate behavior in a controlled-profile pulverized coal-fired reactor: A study of coupled turbulent particle dispersion and thermal radiation transport: Quarterly technical progress report, March 15, 1993–June 14, 1993.** Queiroz, M.; Webb, B.W. Brigham Young Univ., Provo, UT (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91308. Order Number DE94001958. Source: OSTI; NTIS; GPO Dep.

Improved understanding of the fundamental processes involved in pulverized-coal combustion is needed to make the energy extraction more efficient and the combustion byproducts environmentally safe. While the characterization of the local particulate behavior (concentration, size, and velocity) is important to the understanding of virtually all processes in a pulverized coal-fired furnace, it influences in a more direct way the turbulent particle dispersion and thermal radiation heat transfer. Yet the local particulate dynamics have gone relatively unaddressed, primarily because of lack of adequate instrumentation to carry out such a study. With recent advances in optical techniques such an effort is now possible. This proposal seeks to characterize the local particulate concentration, velocity, and size distribution in a wellcontrolled, parametrically-varied laboratory-scale reactor using a new laser diagnostic technique. This newly-developed technique is the only one currently available for the investigation of aspherical particles. The particulate data will be collected simultaneously with local gas temperature and wall radiant heat flux distributions.

6073 (DOE/PC/92162–T1) **The development of coal-based technologies for Department of Defense facilities: Semiannual technical progress report, September 28, 1992–March 27, 1993.** Miller, B.G. (and others); Scaroni, A.W.; Hogg, R. Pennsylvania State Univ., University Park, PA (United States). 13 May 1993. 133p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-92PC92162. Order Number DE94001983. Source: OSTI; NTIS; GPO Dep.

The US Department of Defense (DOD), through an Interagency Agreement with the US Department of Energy (DOE), has initiated a three-phase program with the Consortium for Coal-Water Slurry Fuel Technology, with the aim of decreasing DOD's reliance on imported oil by increasing its use of coal. The program is being conducted as a cooperative agreement between the Consortium and DOE and the first phase of the program is underway. Phase I activities are focused on developing clean, coal-based combustion technologies for the utilization of both micronized coal-water mixtures (MCWMs) and dry, micronized coal (MC) in fuel oil-designed industrial boilers. Phase II research and development activities will continue to focus on industrial boiler retrofit technologies by addressing emissions control and pre-combustion (i.e., slagging combustion and/or gasification) strategies for the utilization of high ash and high sulfur coals. Phase III activities will examine coal-based fuel combustion systems that cofire wastes. Each phase includes an engineering cost analysis and technology assessment. The activities and status of Phase I are described below. The objective in Phase I is to deliver fully engineered retrofit options for a fuel oil- designed watertube boiler located on a DOD installation to fire either MCWM or MC. This will be achieved through a program consisting of the following five tasks: (1) Coal Beneficiation and Preparation; (2) Combustion Performance Evaluation; (3) Engineering Design; (4) Engineering and Economic Analysis; (5) Final Report/Submission of Design Package.

6074 (DOE/PC/92162–T2) **The development of coal-based technologies for Department of Defense Facilities: Interim report, March 27, 1993–July 30, 1993.** Miller, B.G. (Pennsylvania State Univ., University Park, PA (United States). Energy and Fuels Research Center); Morrison, J.L.; Sharifi, R. Pennsylvania State Univ., University Park, PA (United States). 24 Sep 1993. 110p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract FC22-92PC92162. Order Number DE94003234. Source: OSTI; NTIS; GPO Dep.

The US Department of Defense (DOD), through an Interagency Agreement with the US Department of Energy (DOE), has initiated a three-phase program with the Consortium for Coal-Water Slurry Fuel Technology, with the aim of decreasing DOD's reliance on imported oil by increasing its use of coal. The program is being conducted as a cooperative agreement between the Consortium and DOE and the first phase of the program is underway. Phase I activities are focused on developing clean, coal-based combustion technologies for the utilization of both micronized coal-water slurry fuels (MCWSFs) and dry, micronized coal (DMC) in fuel oil-designed industrial boilers. Phase II research and development activities will continue to focus on industrial boiler retrofit technologies by addressing emissions control and precombustion (i.e., slagging combustion and/or gasification) strategies for the utilization of high ash, high sulfur coals. Phase III activities will examine coal-based fuel combustion systems that cofire wastes. Each phase includes an engineering cost analysis and technology assessment. The activities and status of Phase I are described below. The objective in Phase I is to deliver fully engineered retrofit options for a fuel oil-designed watertube boiler located on a DOD installation to fire either MCWSF or DMC. This will be achieved through a program consisting of the following five tasks: (1) Coal Beneficiation and Preparation; (2) Combustion Performance Evaluation; (3) Engineering Design; (4) Engineering and Economic Analysis; and (5) Final Report/Submission of Design Package.

6075 (DOE/PC/92176–T3) **Thermodynamic properties of pulverized coal during rapid heating devolatilization processes: Quarterly progress report, April–June 1993.** Proscia, W.M.; Freihaut, J.D. United Technologies Research Center, East Hartford, CT (United States). Aug 1993. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92176. Order Number DE94002175. Source: OSTI; NTIS; GPO Dep.

Knowledge of the thermodynamic and morphological properties of coal associated with rapid heating decomposition pathways is essential to progress in coal utilization technology. Specifically, knowledge of the heat of devolatilization, surface area and density of coal as a function of rank characteristics, temperature and extent of devolatilization in the context of rapid heating conditions is essential to the fundamental determination of kinetic parameters of coal devolatilization. These same properties are also needed to refine existing devolatilization sub-models utilized in large-scale modeling of coal combustion systems. The objective of this research is to obtain data on the thermodynamic properties and morphology of coal under conditions of rapid heating. Specifically, the total heat of devolatilization, external surface area, BET surface area and true density will be measured for representative coal samples. The coal ranks to be investigated will include a high volatile A bituminous (PSOC 1451 D) and a low volatile bituminous (PSOC 1516D). An anthracite (PSOC 1468) will be used as a non-volatile coal reference. In addition, for one coal, the contribution of each of the following components to the overall heat of devolatilization will be measured: the specific heat of coal/char during devolatilization, the heat of thermal decomposition of the coal, the specific heat capacity of tars, and the heat of vaporization of tars.

6076 (DOE/PC/92528–4) **Char particle fragmentation and its effect on unburned carbon during pulverized coal combustion: Quarterly report, July 1, 1993–September 30, 1993.** Diaz, R.; Mitchell, R.E. Stanford Univ., CA (United States). High Temperature Gasdynamics Lab. Oct 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92528. Order Number DE94004541. Source: OSTI; NTIS; GPO Dep.

The overall objectives of the project are: (1) to correlate char particle porosity with fragmentation phenomena, (2) to determine if mineral matter in the coal affects fragmentation patterns, and (3) to relate the effects of fragmentation events to unburned carbon in ash. The knowledge obtained during the course of this project will be used to predict accurately the overall mass loss rates of coals based on the mineral content and porosity of their chars. The work will provide a means of assessing reasons for unburned carbon in the ash of coal fired boilers and furnaces. The project is divided into four research tasks. Specific objectives associated with each task are as follows: Task 1–production and characterization of synthetic chars; Task 2–baseline char combustion experiments; Task 3–char fragmentation studies; and Task 4–fragmentation modeling. Results from the first two tasks are presented.

6077 (DOE/PC/92548–T4) **Suppression of fine ash formation in pulverized coal flames: Quarterly technical progress report No. 4, July 1, 1993–September 30, 1993.** Kramlich, J.C.; Hoffman, D.A.; Butcher, E.K. Washington Univ., Seattle, WA (United States). Dept. of Mechanical Engineering. 29 Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92548. Order Number DE94005045. Source: OSTI; NTIS; GPO Dep.

Laboratory work and studies of full-scale coal-fired boilers have identified two general mechanisms for ash production. The vast majority of the ash is formed from mineral matter that coalesces as the char burns, yielding particles that are normally larger than 0.5 μm. The second major mechanism is the generation of a submicron aerosol through a vaporization/condensation mechanism. Previous work has shown that pulverized bituminous coals that were treated by coal cleaning (via froth flotation) or aerodynamic sizing exhibited altered aerosol emission characteristics. Specifically, the emissions of aerosol for the cleaned and sized coals increased by as much as one order of magnitude. The goals of the present progress are to: (1) perform measurements on carefully characterized coals to identify the means by which the coal treatment increases aerosol yields; (2) investigate means by which coal cleaning can be done in a way that will not increase aerosol yields; (3) identify whether this mechanism can be used to reduce aerosol yields from systems burning straight coal. This paper discusses model description and model formulation, and reports on the progress of furnace design and construction, and coal selection.

6078 (NEDO-C–9212, pp. 1-9) **Combustion technologies and clean coal technologies.: Current situation in studies in the Netherlands, Germany, Austria and the United Kingdom.** Hirama, T. (Government Industrial Development Laboratory, Hokkaido, Sapporo (Japan)). New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. (In Japanese). In *Fiscal 1992 international joint research study made by coal production/utilization technology incentive subsidies.: Survey by researchers sent overseas.* 643p. Order Number DE94732341. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

This paper introduces the results of investigations on studies of technologies for environmental measures associated with coal combustion in the Netherlands, Germany, Austria and the United Kingdom. No decisive means have been obtained yet to reduce emission of N2O generated in a large quantity from a fluidized bed system with low combustion temperatures. A pressurized fluidized bed combustion (PFBC) is used to improve energy efficiency as a new technology to reduce CO2 emission from coal combustion. Similar system is being discussed in EC for use with coal dust combustion system. A key to the PFBC technology is a development of a technology for high-performance dust collection under elevated temperatures, for which studies are being carried out on ceramics filters and precoat filters. The EC member countries have begun studies on combustion systems to rationalize the CO2 recovery process by circulating exhaust gas and mixing oxygen or oxygen-enriched gas with the exhaust. The Coal Research Establishment in the United Kingdom is moving forward smoothly studies on a partial gasification process using a pressurized spouted bed with a capacity of 12 t/d and a topping cycle of pilot plant scale.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 6047, 6770

6079 (DOE/EIA–0121(93/2Q)) **Quarterly coal report, April–June 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. 26 Nov 1993. 168p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003694. Source: OSTI; NTIS; GPO; GPO Dep.

In the second quarter of 1993, the United States produced 235 million short tons of coal. This brought the total for the first half of 1993 to 477 million short tons, a decrease of 4 percent (21 million short tons) from the amount produced during the first half of 1992. The decrease was due to a 26-million-short-ton decline in production east of the Mississippi River, which was partially offset by a 5-million-short-ton increase in coal production west of the Mississippi River. Compared with the first 6 months of 1992, all States east of the Mississippi River had lower coal production levels, led by West Virginia and Illinois, which produced 9 million short tons and 7 million short tons less coal, respectively. The principal reasons for the drop in coal output for the first 6 months of 1993 compared to a year earlier were: a decrease in demand for US coal in foreign markets, particularly the steam coal markets; a draw-down of electric utility coal stocks to meet the increase in demand for coal-fired electricity generation; and a lower producer/distributor stock build-up. Distribution of US coal in the first half of 1993 was 15 million short tons lower than in the first half of 1992, with 13 million short tons less distributed to overseas markets and 2 million short tons less distributed to domestic markets.

6080 (NEDO-C–9212) **Fiscal 1992 international joint research study made by coal production/utilization technology incentive subsidies.: Survey by researchers sent overseas.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 643p. (In Japanese). Order Number DE94732341. Source: OSTI; NTIS; Available from New Energy

and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

This paper investigates the trend of the coal utilization technology research and development overseas to make R and D and promote commercialization of the clean coal technology (CCT). As for the Netherland and Germany, report is made on the pressurized fluidized bed combustion, deashing, and NOx/N2O control measures. As to Austria, stated are air pollution measuring technology and coal thermal cracking. About the U.K., introduced is a study on topping cycle into which the pressurized spouted bed gasification and the gasified residue combustion are integrated. Brown coal in Spain is inferior in quality, and therefore the pressurized fluidized bed combustion and the gasification combined cycle power generation are now under development. Brown coal utilization and environment preservation measures in Czechoslovakia are also mentioned. Concerning the U.S., the paper describes the coal gasification combined cycle power generation, ash handling, the fluidized bed combustion, and the development of the bubble column coal washing technology. Also described are removal of organic sulfur from coal by perchloroethylene, and simultaneous removal of SOx, NOx and dust from exhaust gas. In Finland and Sweden, study tours are made of the pressurized fluidized bed combustion and gasification the circulating fluidized bed boiler, etc. 66 refs., 35 figs., 28 tabs.

6081 (NEDO-C–9212, pp. 51-72) **Report of 'Investigation on trends in studies of low-grade coal utilization technologies in East Europe'.** Tsutsumi, A. (The University of Tokyo, Tokyo (Japan). Faculty of Engineering). New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. (In Japanese). In *Fiscal 1992 international joint research study made by coal production/utilization technology incentive subsidies.: Survey by researchers sent overseas.* 643p. Order Number DE94732341. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

This paper is a report on investigations of the current situation in Czechoslovakia of brown coal utilization technologies and their environmental influence. Because the SOx and NOx emission sources in Czechoslovakia are concentrated in the North Bohemian territory, the SOx emission per unit area is the largest in Europe, and air pollution is growing more serious. Czechoslovakian brown coal has high water content, sulfur content at as high as 3% in average, and ash content as high as 30% in average, but as low calorific power as 9000 to 14500 KJ/g, hence it is disadvantageous in environmental and cost aspects. The largest contaminant producing source is coal burning thermal power plant, where no desulfurizing equipment is installed in spite of the high sulfur content in coals. Consequently, the amount of SOx emitted annually has reached three million tons in early 1980. Coal complexes are performing production of coals and household solid fuels, coal gasification, and electric power generation. The Basic Chemical Process Research Institute of Czechoslovakia proposes a process to recover heavy metals from waste water using low-grade coal as an ion exchanging agent. 13 figs., 11 tabs.

02 PETROLEUM

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 6088, 7176, 7185

6082 (NIPER–724) **Data from selected Almond Formation outcrops – Sweetwater County, Wyoming.** Jackson, S.R.; Rawn-Schatzinger, V. National Inst. for Petroleum and Energy Research, Bartlesville, OK (United States). Dec 1993. 76p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-83FE60149. Order Number DE94000110. Source: OSTI; NTIS; GPO Dep.

The objectives of this research program are to: (1) determine the reservoir characteristics and production problems of shoreline barrier reservoirs; and (2) develop methods and methodologies to effectively characterize shoreline barrier reservoirs to predict flow patterns of injected and produced fluids. Two reservoirs were selected for detailed reservoir characterization studies – Bell Creek field, Carter County, Montana, that produces from the Lower Cretaceous (Albian-Cenomanian) Muddy Formation, and Patrick Draw field, Sweetwater County, Wyoming that produces from the Upper Cretaceous (Campanian) Almond Formation of the Mesaverde Group. An important component of the research project was to use information from outcrop exposures of the producing formations to study the spatial variations of reservoir properties and the degree to which outcrop information can be used in the construction of reservoir models. A report similar to this one presents the Muddy Formation outcrop data and analyses performed in the course of this study (Rawn-Schatzinger, 1993). Two outcrop localities, RG and RH, previously described by Roehler (1988) provided good exposures of the Upper Almond shoreline barrier facies and were studied during 1990–1991. Core from core well No. 2 drilled approximately 0.3 miles downdip of outcrop RG was obtained for study. The results of the core study will be reported in a separate volume. Outcrops RH and RG, located about 2 miles apart were selected for detailed description and drilling of core plugs. One 257-ft-thick section was measured at outcrop RG, and three sections ~145 ft thick located 490 and 655 feet apart were measured at the outcrop RH. Cross-sections of these described profiles were constructed to determine lateral facies continuity and changes. This report contains the data and analyses from the studied outcrops.

0203 Drilling and Production

Refer also to citation(s) 6105

6083 (CONF-9305134–, pp. 271-278) **Modeling aspects of wave kinematics in offshore structures dynamics.** Spanos, P.D. (Rice Univ., Houston, TX (United States)); Ghanem, R.; Bhattacharjee, S. Argonne National Lab., IL (United States). 1993. DOE Contract FG05-91ER14215. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Magnitude and phase related issues of modeling of ocean wave kinematics are addressed. Causal and non-causal filters are examined. It is shown that if for a particular ocean engineering problem only the magnitude representation of wave spectra spatial relation is critical, analog filters can be quite useful models in conjunction with the technique of statistical linearization, for calculating dynamic analyses. This is illustrated by considering the dynamic response of a simple model of a guyed tower.

6084 (DOE/BC/14886–4) **Investigation of oil recovery improvement by coupling an interfacial tension agent and a mobility control agent in light oil reservoirs: Technical progress report, July–September 1993.** Pitts, M.J. Surtek, Inc., Golden, CO (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92BC14886. Order Number DE94003568. Source: OSTI; NTIS; GPO Dep.

The study will investigate two major areas concerning coinjecting an interfacial tension reduction agent(s) and a mobility control agent into petroleum reservoirs. The first will consist of defining the mechanisms of interaction of an alkaline agent, a surfactant, and a polymer on a fluid-fluid and a fluid-rock basis. The second is the improvement of the economics of the combined technology. This report examines the effect of polymer addition to different combinations of alkaline agents and surfactants. Xanthan gum and polyacrylamide polymers were evaluated. In addition, the effect of alkali and polymer on the critical micelle concentration of different surfactant types was investigated.

6085 (DOE/BC/14958–4) **Green River Formation Water Flood Demonstration Project, Uinta Basin, Utah: Quarterly technical progress report, July 1, 1993–September 30, 1993.** Lomax, J.D. (Lomax Exploration Co., Salt Lake City, UT (United States)); Nielson, D.L.; Deo, M.D. Lomax Exploration Co., Salt Lake City, UT (United States). [1993]. 16p. Sponsored by USDOE,

Washington, DC (United States). DOE Contract FC22-93BC14958. Order Number DE94003567. Source: OSTI; NTIS; GPO Dep.

The project is designed to increase recoverable petroleum reserves in the United States. The Green River Formation in Utah's Uinta Basin contains abundant hydrocarbons that are not easily recovered by primary means. The successful Lomax Montument Butte Unit water flood will be evaluated under this contract, and based on this information, water floods will be initiated in nearby Travis and Boundary units. In 1987, Lomax Exploration Company started a water flood in the Monument Butte Unit of a Douglas Creek member of the Green River Formation. This was a low-enererey, geologically heterogeneous reservoir producing a waxy crude oil. Primary production yielded 5% of the OOIP. Due to the water flood project, total production will yield an estimated recovery of 20% OOIP.

6086 (DOE/MC/26031–3462) **Field verification of CO_2-foam: Annual report.** Martin, F.D.; Heller, J.P.; Weiss, W.W. New Mexico Petroleum Recovery Research Center, Socorro, NM (United States). Nov 1992. 80p. Sponsored by USDOE, Washington, DC (United States);New Mexico State Government, Santa Fe, NM (United States). DOE Contract FG21-89MC26031. Order Number DE94000003. Source: OSTI; NTIS; GPO Dep.

The East Vacuum Grayburg/San Andres Unit (EVGSAU), operated by Phillips Petroleum Company, is the site selected for a comprehensive evaluation of the use of foam for improving the effectiveness of a CO_2 flood. The four-year project, jointly funded by the EVGSAU Working Interest Owners (WIO), the US Department of Energy (DOE), and the State of New Mexico, began in late 1989. The Petroleum Recovery Research Center (PRCC), a division of the New Mexico Institute of Mining and Technology (NMIMT), is providing laboratory and research support for the project. A Joint Project Advisory Team (JPAT) composed of technical representatives from several major oil companies provides input, review, and guidance for the project. This third annual report details various aspects of the CO_2-Foam Field Verification Pilot test at EVGSAU. The report presents: (1) an overview of the operating plan for the project, (2) details of the foam injection schedule and design criteria, (3) a discussion of the data collection program and performance criteria to be used in evaluating successful application of foam for mobility control in the EVGSAU CO_2 project, and (4) preliminary results from the field injection test. Specific items discussed in the foam injection design include the determination of surfactant volume and concentration, selection of the surfactant-alternating-gas (SAG) injection sequence for foam generation, field facilities, operations during foam injection, and contingency plans. An extensive data collection program for the project is discussed including production testing, injection well pressure and rate monitoring, injection profiles, production well logging, observation well logging program, and both gas and water phase tracer programs.

6087 (NIPER–661) **Feasibility of steam injection process in a thin, low-permeability heavy oil reservoir of Arkansas – a numerical simulation study.** Sarkar, A.K.; Sarathi, P.S. National Inst. for Petroleum and Energy Research, Bartlesville, OK (United States). Dec 1993. 109p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-83FE60149. Order Number DE94000112. Source: OSTI; NTIS; GPO Dep.

This report details the findings of an in-depth study undertaken to assess the viability of the steam injection process in the heavy oil bearing Nacatoch sands of Arkansas. Published screening criteria and DOE's steamflood predictive models were utilized to screen and select reservoirs for further scrutiny. Although, several prospects satisfied the steam injection screening criteria, only a single candidate was selected for detailed simulation studies. The selection was based on the availability of needed data for simulation and the uniqueness of the reservoir. The reservoir investigated is a shallow, thin, low-permeability reservoir with low initial oil saturation and has an underlying water sand. The study showed that the reservoir will respond favorably to steamdrive, but not to cyclic steaming. Steam stimulation, however, is necessary to improve steam injectivity during subsequent steamdrive. Further, in such marginal heavy oil reservoirs (i.e., reservoir characterized by thin pay zone and low initial oil saturation) conventional steamdrive (i.e., steam injection using vertical wells) is unlikely to be economical, and nonconventional methods must be utilized. It was found that the use of horizontal injectors and horizontal producers significantly improved the recovery and oil-steam ratio and improved the economics. It is recommended that the applicability of horizontal steam injection technology in this reservoir be further investigated.

6088 (NIPER–714) **Surfactant-enhanced alkaline flooding field project: Annual report.** French, T.R.; Josephson, C.B. National Inst. for Petroleum and Energy Research, Bartlesville, OK (United States). Dec 1993. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-83FE60149. Order Number DE94000111. Source: OSTI; NTIS; GPO Dep.

The Tucker sand from Hepler field, Crawford County, Kansas, was characterized using routine and advanced analytical methods. The characterization is part of a chemical flooding pilot test to be conducted in the field, which is classified as a DOE Class I (fluvial-dominated delta) reservoir. Routine and advanced methods of characterization were compared. Traditional wireline logs indicate that the reservoir is vertically compartmentalized on the foot scale. Routine core analysis, X-ray computed tomography (CT), minipermeameter measurement, and petrographic analysis indicate that compartmentalization and lamination extend to the microscale. An idealized model of how the reservoir is probably structured (complex layering with small compartments) is presented. There was good agreement among the several methods used for characterization, and advanced characterization methods adequately explained the coreflood and tracer tests conducted with short core plugs. Tracer and chemical flooding tests were conducted in short core plugs while monitoring with CT to establish flow patterns and to monitor oil saturations in different zones of the core plugs. Channeling of injected fluids occurred in laboratory experiments because, on core plug scale, permeability streaks extended the full length of the core plugs. A graphic example of how channeling in field core plugs can affect oil recovery during chemical injection is presented. The small scale of compartmentalization indicated by plugs of the Tucker sand may actually help improve sweep between wells. The success of field-scale waterflooding and the fluid flow patterns observed in highly heterogeneous outcrop samples are reasons to expect that reservoir flow patterns are different from those observed with short core plugs, and better sweep efficiency may be obtained in the field than has been observed in laboratory floods conducted with short core plugs.

6089 (NIPER–727) **Literature survey and documentation on organic solid deposition problem: Status report.** Chung, Ting-Horng. National Inst. for Petroleum and Energy Research, Bartlesville, OK (United States). Dec 1993. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-83FE60149. Order Number DE94005200. Source: OSTI; NTIS; GPO Dep.

Organic solid deposition is often a major problem in petroleum production and processing. Recently, this problem has attracted more attention because operating costs have become more critical to the profit of oil production. Also, in miscible gas flooding, asphaltene deposition often occurs in the wellbore region after gas breakthrough and causes plugging. The organic deposition problem is particularly serious in offshore oil production. Cooling of crude oil when it flows through long-distance pipelines under sea water may cause organic deposition in the pipeline and result in plugging. NIPER's Gas EOR Research Project has been devoted to the study of the organic solid deposition problem for three years. NIPER has received many requests for technical support. Recently, the DeepStar project committee on thermo-technology development and standardization has asked NIPER to provide them with NIPER's expertise and experience. To assist the oil industry, NIPER is preparing a state-of-the-art review on the technical development for the organic deposition problem. In the first quarter, this project has completed a literature survey and documentation. total of 258 publications (114 for wax, 124 for asphaltene, and 20 for related subjects) were collected and categorized. This literature survey was focused on the two subjects: wax and asphaltene. The subjects of bitumen, asphalt, and heavy oil are not included. Also, the collected publications are mostly related to production problems.

6090 (SAND–93-2239) **Core based stress measurements: A guide to their application: Topical report, July 1991–June 1993.** Warpinski, N.R. (Sandia National Labs., Albuquerque, NM (United States)); Teufel, L.W.; Lorenz, J.C.; Holcomb, D.J. Gas Research Inst., Chicago, IL (United States); Sandia National Labs., Albuquerque, NM (United States). Jun 1993. 149p. Sponsored by Gas Research Inst., Chicago, IL (United States). DOE Contract AC04-94AL85000. (GRI–93/0270). Order Number DE94005291. Source: OSTI; NTIS; GPO Dep.

This report is a summary and a guide to core-based stress measurements. It covers anelastic strain recovery, circumferential velocity anistropy, differential strain curve analysis, differential wave velocity analysis, petrographic examination of microcracks, overcoring of archieved core, measurements of the Kaiser effect, strength anisotropy tests, and analysis of coring-induced fractures. The report begins with a discussion of the stored energy within rocks, its release during coring, and the subsequent formation of relaxation microcracks. The interogation or monitoring of these microcracks form the basis for most of the core-based techniques (except for the coring induced fractures). Problems that can arise due to coring or fabric are also presented, Coring induced fractures are discussed in some detail, with the emphasis placed on petal (and petal-centerline) fractures and scribe-knife fractures. For each technique, a short description of the physics and the analysis procedures is given. In addition, several example applications have also been selected (where available) to illustrate pertinent effects. This report is intended to be a guide to the proper application and diagnosis of core-based stress measurement procedures.

0204 Processing

6091 (DOE/ER/14221–3) **Partial control of complex processing systems: Progress report, September 15, 1993–September 14, 1994.** Shinnar, R. City Coll., New York, NY (United States). Dept. of Chemical Engineering. [1994]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER14221. Order Number DE94005602. Source: OSTI; NTIS; GPO Dep.

Control of a Fluid Catalytic Cracker (FCC) was chosen. A concern in control of nonlinear processes is the potential existence of multiple steady states and other stability problems. In an FCC, choice of variables in dynamic matrix cannot be based solely on linear control theory. Considerations requiring a nonlinear model are outlined. Linearized theory is suitable and sufficient for controller tuning and design of algorithm at a given steady state. For evaluating stability considerations and for steady-state control and optimization nonlinear models are essential. While a 2 × 2 matrix properly chosen is sufficient for dynamic control and stabilization, additional variables available should enter the overall control scheme in a slow mode. When dealing with impact of disturbances on process while designing a control circuit, emphasis should be given to slow disturbances and changes in inputs. Fast response, while desirable, is not a main criterion in choosing a dynamic control matrix, unless the fast response relates to all crucial variables in Y_p.

6092 (IFP–40719) **Study and modelling of a reactional tube bundle heated by a fluidized bed.** Collantes Hernandez, M.A. Paris-6 Univ., 75 (France); Ecole Nationale Superieure du Petrole et des Moteurs (ENSPM), 92 - Rueil-Malmaison (France). Jul 1993. 157p. (In French). Order Number DE94728740. Source: OSTI; NTIS (US Sales Only).

Fluidized beds exhibit two important characteristics for the heating of a reactional tube bundle: homogeneous temperature within all the fluidized bed and high heat transfer coefficient with the immersed surfaces. One of the key points for their modeling is the knowledge of the vertical and horizontal thermal conductivities and the heat transfer coefficient at the wall or with the tubes of the reactor. As thermal diffusivity data about large fluidized beds are not available in the literature, we have built a large size pilot unit (0.6 m x 1.1 m x 2.8 m) to determine these values under the conditions of a catalytic treatment of petroleum products. The measure of local temperatures and the use of a two-dimensional diffusion model have permitted us to determine thermal conductivities as a function of several parameters: fluidization velocity, height of the bed, nature and granulometry of solids and geometry of the tube bundle. On the basis of the collected experimental data, the case of a petrochemical unit has been studied. A mathematical code was developed, which permitted us to acquire the data concerning the progress of the reaction in the tubes and it also allowed us to analyse the influence of size and density of the tube bundles on the conversion. (author). 72 refs., 90 figs., 15 tabs.

6093 (IFP–40772) **Hydrodynamic of a fluidized bed reactor with cocurrent downflow of gas and solid.** Aubert, E. Institut National Polytechnique, 31 - Toulouse (France); Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison (France). Jul 1993. 275p. (In French). Order Number DE94728741. Source: OSTI; NTIS (US Sales Only).

Gas-solid transport reactors with cocurrent downflow represent a class of contactors with important industrial application yet there is very little detailed knowledge of their hydrodynamic behaviour. An experimental study has been carried out in a 50 mm diameter reactor, 5 m in height, using Fluid Catalytic Cracking catalyst, in order to obtain certain key parameters such as the axial pressure profile, the gas-solid slip velocity, the average solids concentration and the radial profiles of solids flux. The changing axial and radial behaviour of the flow is essentially determined by the superficial gas velocity. At the bottom of the reactor, the radial profile of the solids flux is uniform for $U_g = 3\ m.s^{-1}$. At higher velocities, the flux is greater in the center of the reactor and at lower velocities, the situation is inversed with a more important solids flow at the reactor wall. This apparent ambivalence has been related to the observed sign change of the slip velocity: negative for low superficial gas velocities and positive at higher values. A model based on a schematic representation of the flow structure upholds this explanation. (author).

6094 (IFP–40836) **Gas-liquid fixed bed catalytic reactor: Theoretical and experimental comparison of reactor performance in different flow directions.** Vergel Hernandez, C.A. Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison (France); Institut National Polytechnique, 54 - Nancy (France). Sep 1993. 302p. (In French). Order Number DE94728748. Source: OSTI; NTIS (US Sales Only).

The objective of this study was to investigate the effect of various flow configurations on the performance of a gas-liquid fixed bed catalytic reactor. From a theoretical point of view, the comparison is made on the basis of the different hydrodynamic and mass transfer parameters. A model for this type of reactor has been developed as a tool to determine the way in which each one of these parameters affects the reactor performance. Experimentally, a comparison of the performances obtained with a cocurrent upflow or downflow pilot unit has been done. The selective hydrogenation of butadiene in a C4 cut has been used for this comparison. The obtained selectivity is lower for the downflow than for the upflow arrangement, especially for the lower values of the liquid velocity. It is shown that the degradation in the selectivity is mainly due to problems of liquid distribution across the bed. In the case of trickling flow the problems of liquid distribution are related to the structure of the flow, in which the liquid flows in the form of rivulets with zones of the bed having an imperfect irrigation. A hysteretic behaviour in the cocurrent downflow arrangement has also been observed. (author).

0205 Products and By-Products

6095 (IFP–40849) **Oxidation phenomenons of lubricating oils for gasoline engines working at high temperature.** Maleville, X. Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison (France); Paris-6 Univ., 75 (France); Ecole Nationale Superieure du Petrole et des Moteurs (ENSPM), 92 - Rueil-Malmaison (France). 22 Sep 1993. 150p. (In French). Order Number DE94728747. Source: OSTI; NTIS (US Sales Only).

The objective is to understand the mechanism for the increase of lubricant viscosity and to characterize the products responsible for this phenomenon. With a laboratory oxidation test, we study the resistance to oxidation, the influence of catalyst and the response of stock oils to antioxidants. We note that a stock oil with high

amounts of sulfur and carbon aromatics, with antioxidant and catalyst, presents an inferior resistance with regard to other stock oils. Then we characterize, with physico-chemical and fractionation methods, the organic components formed during the oxidation: volatile products, heavy soluble and insoluble products. The polar components in these products are hydroxyl, carbonyl and carboxyl species. Volatile products formed included oxygenated linear components (without sulfur), water and alkanes, as well as oxygenated cyclic components (lactone) and aromatics, present only in mineral oil. The average molecular weight of these products is inferior to that of the stock oil. Species responsible for the increase viscosity are heavy soluble and insoluble products. Soluble products contain sulfur, have 10% oxygen with a molecular weight of about 1000 g/mol; these originate essentially from aromatics oxidation. Insoluble products have a higher molecular weight of around 2000 g/mol, 20% oxygen and a high amount of sulfur. Sulfur and aromatic constituents of stock oil participate sharply in the formation of insoluble products. Eventually, we propose a mechanism for the increase in viscosity with intermolecular chemical interactions, condensation reactions and formation of macromolecules which lose their affinity to the oil and precipitate. Finally, a study of resistance to oxidation of lubricants, formulated with our mineral stock oil having the same additives, in engine tests, confirm ours results that one of the most important parameters in the oxidation stability of mineral lubricants is the resistance to oxidation. (Abstract Truncated)

0206 Health and Safety

Refer also to citation(s) 6708

6096 (CMI-R–92/A25016) **Mist explosions on offshore structures: Experiments performed at Chr. Michelsen Institute.** Wingerden, K. van; Wilkins, B.; Pedersen, G. Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway). Apr 1992. 66p. Order Number DE94730387. Source: OSTI; NTIS.

This report describes the results of experiments performed to study the effect of the presence of a flammable aerosol on the propagation of flames in gas-air mixtures in obstructed and non-obstructed environments. The work was performed as a cooperation between TNO-Prins Maurits Laboratory in The Netherlands and Chr. Michelsen Institute initiated under the Memorandum of Understanding between Norway and The Netherlands. 7 refs., 28 figs., 7 tabs.

0207 Economic, Industrial, and Business Aspects

Refer also to citation(s) 6770, 6817, 6820, 6828

6097 (DOE/EIA–0109(93/12)) **Petroleum supply monthly: December 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. Dec 1993. 162p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004819. Source: OSTI; NTIS; GPO; GPO Dep.

Data are presented which describe the supply and disposition of petroleum products in the United States and major U.S. geographic regions. The data series describe production, imports and exports, inter-Petroleum Administration for Defense (PAD) District movements, and inventories by the primary suppliers of petroleum products in the United States. Data are presented in two sections: Summary Statistics, presenting a time series of selected petroleum data on a U.S. level, and Detailed Statistics, presenting statistics for the most current month available as well as year to date.

6098 (DOE/EIA–0520(93/11)) **International petroleum statistics report, November 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. 26 Nov 1993. 62p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003616. Source: OSTI; NTIS; GPO Dep.

The International Petroleum Statistics Report presents data on international oil production, demand, imports, exports, and stocks. The report has four sections. Section 1 contains time series data on world oil production, and on oil demand and stocks in the Organization for Economic Cooperation and Development (OECD). This section contains annual data beginning in 1985, and monthly data for the most recent two years. Section 2 presents an oil supply/demand balance for world. This balance is presented in quarterly intervals for the most recent two years. Section 3 presents data on oil imports by OECD countries. This section contains annual data for the most recent year, quarterly data for the most recent twelve months. Section 4 presents annual time series data on world oil production and oil stocks, demand, and trade in OECD countries World oil production and OECD demand data are for the years 1970 through 1992; OECD stocks from 1973 through 1992: and OECD trade from 1982 through 1992.

6099 (DOE/EIA–0520(93/12)) **International petroleum statistics report, December 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Dec 1993. 62p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004513. Source: OSTI; NTIS; GPO; GPO Dep.

The International Petroleum Statistics Report presents data on international oil production, demand, imports, exports, and stocks. The report has four sections. Section 1 contains time series data on world oil production, and on oil demand and stocks in the Organization for Economic Cooperation and Development (OECD). This section contains annual data beginning in 1985, and monthly data for the most recent two years. Section 2 presents an oil supply/demand balance for world. This balance is presented in quarterly intervals for the most recent two years. Section 3 presents data on oil imports by OECD countries. This section contains annual data for the most recent year, quarterly data for the most recent two quarters, and monthly data for the most recent twelve months. Section 4 presents annual time series data on world oil production and oil stocks, demand, and trade in OECD countries. World oil production and OECD demand data are for the years 1970 through 1992; OECD stocks from 1973 through 1992; and OECD trade from 1982 through 1992. 41 tabs.

6100 (DOE/EIA–0538(93/94-10)) **Winter fuels report: Week ending December 10, 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 16 Dec 1993. 77p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004475. Source: OSTI; NTIS; GPO Dep.

The Winter Fuels Report is intended to provide concise, timely information to the industry, the press, policymakers, consumers, analysts, and State and local governments on the following topics: distillate fuel oil net production, imports and stocks on a U.S. level and for all Petroleum Administration for Defense Districts (PADD) and product supplied on a U.S. level; propane net production, imports and stocks on a U.S. level and for PADD's I, II, and III; natural gas supply and disposition and underground storage for the U.S. and consumption for all PADD's; as well as selected National average prices; residential and wholesale pricing data for heating oil and propane for those States participating in the joint Energy Information Administration (EIA)/State Heating Oil and Propane Program; crude oil and petroleum price comparisons for the U.S. and selected cities; and a 6–10 Day, 30-Day, and 90-Day outlook for temperature and precipitation and U.S. total heating degree-days by city. 37 figs., 13 tabs.

6101 (DOE/EIA–0538(93/94-13)) **Winter fuels report: Week ending: December 31, 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 6 Jan 1994. 76p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94005184. Source: OSTI; NTIS; GPO Dep.

The Winter Fuels Report is intended to provide concise, timely information to the industry, the press, policymakers, consumers, analysts, and State and local governments on the following topics: Distillate fuel oil net production, imports and stocks on a U.S. level and for all Petroleum Administration for Defense Districts (PADD) and product supplied on a U.S. level; propane net production, imports and stocks on a U.S. level and for PADD's I,II, and III; natural gas supply and disposition and underground storage for the U.S. and consumption for all PADD's as well as selected National average prices; residential and wholesale pricing data for heating oil and propane for those States participating in the joint Energy Information Administration (EIA)/State Heating Oil and Propane

Program; crude oil and petroleum price comparisons for the U.S. and selected cities; and a 6-10 day, 30 day,and 90 day outlook for temperature and precipitation and U.S. total heating degree-days by city. This report is for the week ending December 31, 1993.

6102 (DOE/EIA–0577(91)) **International oil and gas exploration and development: 1991.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. Dec 1993. 93p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004820. Source: OSTI; NTIS; GPO; GPO Dep.

This report starts where the previous quarterly publication ended. This first publication of a new annual series contains most of the same data as the quarterly report, plus some new material, through 1991. It also presents historical data covering a longer period of time than the previous quarterly report. Country-level data on oil reserves, oil production, active drilling rigs, seismic crews, wells drilled, oil reserve additions, and oil reserve-to-production rations (R/P ratios) are listed for about 85 countries, where available, from 1970 through 1991. World and regional summaries are given in both tabular and graphical form. The most popular table in the previous quarterly report, a listing of new discoveries, continues in this annual report as Appendix A.

6103 (IFP-RA–1992) **Annual Report 1992.** Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison (France). 1993. 59p. (In French). Order Number DE94728742. Source: OSTI; NTIS (US Sales Only).

This annual report presents the main activities of Institut Francais du Petrole in 1992: Pollution abatement in waters, soils and atmosphere; petroleum exploration and reservoirs characterization; drilling methods and drilling equipments development; petroleum refining, lubricating oils and motors.

0208 Waste Management

6104 (DOE/MT/92009–4) **Evaluation of the freeze-thaw/evaporation process for the treatment of produced waters: Quarterly technical progress report, July 1–September 30, 1993.** Boysen, J.; Morotti, J. Resource Technology Corp., Laramie, WY (United States). Oct 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92MT92009. Order Number DE94003562. Source: OSTI; NTIS; GPO Dep.

The objectives of this research are related to development of a commercially-economic natural freeze-thaw/evaporation (FTE) process for the treatment and purification of water produced in conjunction with oil and gas. During the reporting period of July 1, 1993 to September 30, 1993, project research concentrated on Subtasks 2.0 (Task 2 Project Reporting) and 2.1 (Laboratory-scale FTE Simulations). The objectives of Task 2 are to conduct laboratory- and bench-scale simulations for optimizing the design of the FTE process. Task 2 requires completion of six subtasks: Subtask 2.0 – Task 2 Project Reporting (initiated March 1, 1993), Subtask 2.1 – Laboratory-scale FTE Simulations, Subtask 2.2 – Re-evaluation of Process Economics Based on Laboratory-scale Process Simulation Results, Subtask 2.3 – Bench-scale FTE Simulations, Subtask 2.4 – Economic Assessment of Bench-scale Simulations, and Subtask 2.5 – Technical Report of Task 2. The construction and operation of the laboratory-scale process simulations planned for this quarter (Subtask 2.1) have been delayed until the contract modification to obtain co-funding from the Gas Research Institute (GRI) through their subcontractor Remediation Technologies, Inc. (RETEC) is in place.

0209 Environmental Aspects

6105 (DOE/EIS–0158-FS) **Petroleum production at Maximum Efficient Rate Naval Petroleum Reserve No. 1 (Elk Hills), Kern County, California: Final Supplemental Environmental Impact Statement.** USDOE Naval Petroleum Reserves in California, Tupman, CA (United States). Jul 1993. 1167p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003608. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides an analysis of the potential impacts associated with the proposed action, which is continued operation of Naval Petroleum Reserve No. I (NPR-1) at the Maximum Efficient Rate (MER) as authorized by Public law 94-258, the Naval Petroleum Reserves Production Act of 1976 (Act). The document also provides a similar analysis of alternatives to the proposed action, which also involve continued operations, but under lower development scenarios and lower rates of production. NPR-1 is a large oil and gas field jointly owned and operated by the federal government and Chevron U.SA Inc. (CUSA) pursuant to a Unit Plan Contract that became effective in 1944; the government's interest is approximately 78% and CUSA's interest is approximately 22%. The government's interest is under the jurisdiction of the United States Department of Energy (DOE). The facility is approximately 17,409 acres (74 square miles), and it is located in Kern County, California, about 25 miles southwest of Bakersfield and 100 miles north of Los Angeles in the south central portion of the state. The environmental analysis presented herein is a supplement to the NPR-1 Final Environmental Impact Statement of that was issued by DOE in 1979 (1979 EIS). As such, this document is a Supplemental Environmental Impact Statement (SEIS).

6106 (DOE/MT/92001–4) **Environmental and economic assessment of discharges from Gulf of Mexico region oil and gas operations: Quarterly technical progress report, April–June 1993.** Gettleson, D.A. Continental Shelf Associates, Inc., Jupiter, FL (United States). 26 Jul 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92MT92001. Order Number DE94003278. Source: OSTI; NTIS; INIS; GPO Dep.

Continental Shelf Associates, Inc. (CSA) was contracted to conduct a three-year study of the environmental and health related impacts of produced water and sand discharges from oil and gas operations. Data on naturally occurring radioactive materials (NORM), heavy metals, and hydrocarbons in water, sediment, and biota will be collected and evaluated. Health related impacts will be studied through field collections and analyses of commercially- and recreationally-important fish and shellfish tissues. Additionally, information on seafood catch, consumption, and use patterns for the Gulf of Mexico will be gathered and analyzed. The facilities to be studied will include both offshore and coastal facilities in the Gulf of Mexico. Coastal sites will be additionally studied to determine ecological recovery of impacted wetland and open bay areas. The economic impact of existing and proposed effluent federal and state regulations will also be evaluated. The primary objectives of the project are to increase the base of scientific knowledge concerning (1) the fate and environmental effects of organics, trace metals, and NORM in water, sediment, and biota near several offshore oil and gas facilities; (2) the characteristics of produced water and produced sand discharges as they pertain to organics, trace metals, and NORM variably found in association with the discharges; (3) the recovery of four terminated produced water discharge sites located in wetland and high-energy open bay sites of coastal Louisiana and Texas; (4) the economic and energy supply impacts of existing and anticipated federal and state offshore and coastal discharge regulations; and (5) the catch, consumption and human use patterns of seafood species collected from coastal and offshore waters. Accomplishments for this period are described.

6107 (IFP–40783) **Macrostructure of smectite - water systems: influence of anionic polyelectrolytes upon organization of montmorillonite suspensions.** Morvan, M. Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison (France); Paris-6 Univ., 75 (France). May 1993. 260p. (In French). Order Number DE94728746. Source: OSTI; NTIS (US Sales Only).

In this report, we have investigated aqueous smectite clay suspensions (montmorillonite or laponite), containing a low molecular weight sodium polyacrylate. Actually, this polyelectrolyte serves as a dispersing agent in drilling fluids based on smectite and water. In order to describe these clay suspensions, we have employed different characterization methods: small angle X-ray scattering (SAXS) using a Holmes and a Bonse-Hart apparatus, osmotic pressure measurements and NMR relaxation. We have shown that the model presented in the literature to convert proton relaxation measurements, in term of external surface area of clay particles available to water, was not adapted. The SAXS results indicate otherwise, that sodium smectite clay suspensions were mainly composed of elementary clay sheets, whose organisation leads to

a two phase system. Aggregation of the clay platelets occurs when divalent cations act as clay counterions, but also under an increase of the medium ionic strength. We have proposed schematic illustrations to describe in each cases the structure of the system. When added to a sodium montmorillonite suspension, the sodium polyacrylate gives rise to a strong orientation of the clay sheets. Our results indicate that this organisation must be attributed to an osmotic effect of the polyelectrolyte expelled from the interlayer space. Then, we have shown that the dispersing effect of the polyelectrolyte on calcium montmorillonite suspensions, was due to an ion exchange of the calcium clay counterions by the sodium provided by the polyelectrolyte. (author).

6108 (NREL/CP–200-5768-Vol.2, pp. 1485-1493) **Commercial production of the oil absorbent Sea Sweep.** Reed, T.B. (Colorado School of Mines, Golden, CO (United States)); Mobeck, W.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

A new absorbent has been developed for oil spills. It attracts oil and chemicals and floats on water indefinitely. It is mpm-leaching and can save land and beaches from environmental disasters and can be disposed of in an environmentally acceptable manner or recycled. The new absorbent is called "Sea Sweep"; extensive research has been done on it under an EPA Small Business Innovation Research grant, Phase I and Phase II. Sea Sweep has been tested for toxicity to the environment. Less than 2 mg/l total organic carbon was found in water in contact with oil saturated Sea Sweep after 30 minutes. No toxicity was measured to any of the marine or freshwater tested species at any test concentrations. Sea Sweep is made from "pin chips," a waste wood product, using a patented thermolytic process in which the wood is heated to about 300°C. It is a coarse, free-flowing granular material absorbing from 2.6 to 6.6 g/g of oils and chemicals. While originally designed for marine oil spills, it is also very effective for oil and chemical spills on land or water. Sea Sweep has now reached the stage of limited commercialization. A small (5 tons/day) plant has been built in northern Colorado at a wood recycling plant and it has been operated since January 1993. The plant features an afterburner that destroys the blue haze resulting from pyrolysis of the sawdust so that production is environmentally acceptable. Sea Sweep is marketed in 5, 10 and 25 lb plastic bags and 500 lb drop bags. It is also sold in socks, booms pillows and bilge rats. The company will recycle non-toxic materials for the customer using methods developed under the SBIR grant. Sea Sweep has been features in a number of articles, on television, and in national and international trade shows. The international marketing of Sea Sweep is administered from the corporate offices in Denver. Domestic marketing is administered from the regional office in Chicago.

0210 Legislation and Regulations

6109 (DOE/RL–93-85) **Notice of construction for proposed backup package boiler.** USDOE Richland Operations Office, WA (United States). Oct 1993. 82p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004482. Source: OSTI; NTIS; GPO Dep.

The Hanford Site steam plant consists of coal-fired boilers located at the 200 East and the 200 West Areas. These boilers have provided steam to heat and cool facilities in the 200 Areas since the early 1940's. As part of Project L-017, "Steam System Rehabilitation, Phase II", the 200 West Area coal-fired boilers will be permanently shut down. The shut down will only occur after a proposed package backup boiler (50,000 pounds per hour (lb/hr) steam, firing No. 2 oil) is installed at the 200 West Area. The proposed backup boiler will provide back-up services when the 200 East Area steam line, which provides steam to the 200 West Area, is down for maintenance or, when the demand for steam exceeds the supply available from the 200 East Plant. This application is a request for approval to construct and operate the package backup boiler. This request is being made pursuant to Washington Administration Code (WAC) Chapter 173-400, "General Regulations for Air Pollution Sources", and Chapter 173-460, "Controls for New Sources of Toxic Air Pollutants".

0220 Transport, Handling, and Storage

Refer also to citation(s) 6819

6110 (CMR–92-A15009) **Model-based measurement of multiphase flow.** Midttveit, Oe.; Dykesteen, E. Christian Michelsen Research A/S, Bergen (Norway). Aug 1992. 21p. Order Number DE94730380. Source: OSTI; NTIS.

From a multiphase fraction meter for well mixed flow previously developed by Christian Michelsen Research AS (CMR), a multiphase flowrate meter has now been developed. The new flowrate meter is of a non-intrusive design, and mounted in a vertical upwards flow, it will accept flow regimes from dispersed bubble flow to churn flow without any pre-conditioning of the flow. Further development in order to extend the range to cover also slug flow is in progress. To measure flowrates non-intrusively without any mixing device, a signal interpretation model has been developed as a vital part of the system. The signal analysis takes into account knowledge of multiphase flow behavior. Such a knowledge is essential when the complex problem of multiphase flow metering is addressed. This paper therefore provides some basic background theory of vertical upwards gas-liquid flow, and thereafter discusses some important consequences of different flow conditions to a multiphase flow meter. Finally, the concept of the CMR multiphase flowrate meter is presented, together with test results from extensive laboratory testing of this new multiphase flowrate meter. 8 refs., 14 figs.

6111 (CMR–92-A15016) **Christian Michelsen Research (CMR) multiphase flow rig: Reference system uncertainties.** Hilland, J. Christian Michelsen Research A/S, Bergen (Norway). Nov 1992. 34p. Order Number DE94730379. Source: OSTI; NTIS.

This document gives a description of the 4 inches multiphase flow loop at Christian Michelsen Research (CMR). The single phase reference measurement system is described, and associated measurement uncertainties are discussed and evaluated. The result is a specification of the uncertainties in reference measurements when using this loop for testing the performance of multiphase flow meters. 11 figs., 2 tabs.

6112 (NUTEK-R–92-3) **Strategic storage of petroleum products.** Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1993. 44p. (In Swedish). Order Number DE94730432. Source: OSTI; NTIS.

The security policy has changed during the last years, which means that the present volume of the strategic reserves of petroleum products may be decreased. This investigation shows that with the proposed decentralized storage structure, founded on basic, median- and end use storages, the system availability will reach a lowest acceptable level. It is also economically attractive compared to the recent structure with a number of large, remotely situated storages.

0230 Properties and Composition

Refer also to citation(s) 6114

6113 (DOE/MC/11076–3539) **The characterization of petroleum residua.** Schabron, J.F.; Gardner, G.W.; Hart, J.K.; Niss, N.D.; Miyake, G.; Netzel, D.A. Western Research Inst., Laramie, WY (United States). Aug 1993. 62p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-86MC11076. Order Number DE94000065. Source: OSTI; NTIS; GPO Dep.

Six petroleum residua labeled A through F were separated and characterized by a scheme developed by Western Research Institute. The residua were labeled A through F since their identities were proprietary. Each residuum was deasphaltened in heptane, and the heptane-soluble materials were separated into saturate, aromatic, and polar fractions on activated silica gel. The asphaltenes also were separated into four fractions according to

apparent molecular size by preparative size exclusion chromatography (SEC). The whole residua were evaluated for elemental composition, trace metals content, molecular weight, carbon residue, analytical SEC profiles, and aromaticity by nuclear magnetic resonance spectroscopy. The preparative SEC fractions from the asphaltenes were evaluated for sulfur content, molecular weight, and trace metals content. Material balances showed that the data obtained on the fractions account for the data obtained on the original material. This indicates that the contributions of the properties of the fractions can be studied and related to properties of the whole material.

0250 Combustion

6114 (BNL–49630) **Small oil-fired heating equipment: The effects of fuel quality.** Litzke, W. Brookhaven National Lab., Upton, NY (United States). Aug 1993. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE94004725. Source: OSTI; NTIS; GPO Dep.

The physical and chemical characteristics of fuel can affect its flow, atomization, and combustion, all of which help to define the overall performance of a heating system. The objective of this study was to evaluate the effects of some important parameters of fuel quality on the operation of oil-fired residential heating equipment. The primary focus was on evaluating the effects of the fuel's sulfur content, aromatics content, and viscosity. Since the characteristics of heating fuel are generally defined in terms of standards (such as ASTM, or state and local fuel-quality requirements), the adequacy and limitations of such specifications also are discussed. Liquid fuels are complex and their properties cannot generally be varied without affecting other properties. To the extent possible, test fuels were specially blended to meet the requirements of the ASTM limits but, at the same time, significant changes were made to the fuels to isolate and vary the selected parameters over broad ranges. A series of combustion tests were conducted using three different types of burners – a flame-retention head burner, a high static-pressure-retention head burner, and an air-atomized burner. With some adjustments, such modern equipment generally can operate acceptably within a wide range of fuel properties. From the experimental data, the limits of some of the properties could be estimated. The property which most significantly affects the equipment's performance is viscosity. Highly viscous fuels are poorly atomizated and incompletely burnt, resulting in higher flue gas emissions. Although the sulfur content of the fuel did not significantly affect performance during these short-term studies, other work done at BNL demonstrated that long-term effects due to sulfur can be detrimental in terms of fouling and scale formation on boiler heat exchanger tubes.

03 NATURAL GAS

0303 Drilling, Production, and Processing

Refer also to citation(s) 6090

6115 (DOE/MC/26024–3528) **Slant hole completion test: Final report.** Mann, R.L. CER Corp., Las Vegas, NV (United States). Jul 1993. 93p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-90MC26024. Order Number DE94000053. Source: OSTI; NTIS; GPO Dep.

One of the Department of Energy's (DOE) Strategies and Objectives in the Natural Gas Program is to conduct activities to transfer technology from R&D programs to potential users. The Slant Hole Completion Test has achieved exactly this objective. The Slant Hole site is essentially the same as the Multiwell site and is located in the southeastern portion of the Piceance Basin near Rifle, Colorado. The Piceance Basin is typical of the Western low permeability basins that contain thick sequences of sands, silts and coals deposited during the Cretaceous period. These sequences contain vast amounts of natural gas but have proven to be resistant to commercial production because of the low permeability of the host rocks. Using the knowledge gained from the DOE's earlier Multiwell experiment, the SHCT-1 was drilled to demonstrate that by intersecting the natural fractures found in these "tight rocks," commercial gas production can be obtained.

0304 Products and By-Products

Refer also to citation(s) 6008

0305 Health and Safety

Refer also to citation(s) 6096, 6708

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 6100, 6101, 6102, 6770

6116 (DOE/EIA–0130(93/12)) **Natural gas monthly: December 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. Dec 1993. 127p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004818. Source: OSTI; NTIS; GPO; GPO Dep.

The Natural Gas Monthly (NGM) highlights activities, events, and analyses of interest to public and private sector organizations associated with the natural gas industry. Volume and price data are presented each month for natural gas production, distribution, consumption, and interstate pipeline activities. Producer-related activities and underground storage data are also reported. Articles are included which are designed to assist readers in using and interpreting natural gas information.

0307 Waste Management

Refer also to citation(s) 6104

0308 Environmental Aspects

Refer also to citation(s) 6106, 6107

0320 Transport, Handling, and Storage

Refer also to citation(s) 6110, 6111, 6819

6117 (CMR–92-A10005) **A new multi-path ultrasonic flow meter for gas.** Lygre, A. (Christian Michelsen Research A/S, Bergen (Norway)); Folkestad, T.; Sakariassen, R.; Aldal, D. Christian Michelsen Research A/S, Bergen (Norway). Oct 1992. 19p. Order Number DE94730381. Source: OSTI; NTIS.

Offshore metering stations based on orifice plates are bulky and require much space. Accordingly, the platform costs are considerable, and can be significantly lowered if the size of the metering station is reduced. Ultrasonic transit time multi-path meters will allow compact metering stations to be constructed due to increased flow meter capacity and reduced installation lengths. In addition these meters offer improved flow meter performance and potential for simpler maintenance procedures. A new multi-path flow meter for gas has been developed by Christian Michelsen Research in Norway. The flow meter has undergone testing on natural gas at K-lab, Norway. The flow meter (FMU 700) will be manufactured by Fluenta AS. The FMU 700 features new technical solutions such as titanium housed ultrasonic transducers, automatic gain control, online measurement of transit time delay in cables and electronics, and software pulse detection. The deviations between the K-lab sonic-nozzle reference mass metering system and the FMU 700 are less than 0.8% at gas velocities between 1 and 8 m/s. These results were achieved with 10D straight inlet pipe downstream of a 90° bend. Tests were also performed with the FMU 700 installed only 5D downstream a 90° bend. At gas velocities between 2 and 8 m/s the measurement uncertainty is not changed despite the reduction in upstream straight pipe length from 10D to 5D. The observed deviations were independent of the test pressure varying from 55 to 100 bar. The test results show that it is quite feasible to build a very compact and light metering station compared to conventional solutions and at the same time comply with the requirements set to fiscal metering stations. 7 refs., 14 figs., 1 tab.

0340 Combustion

Refer also to citation(s) 6914

6118 (NUTEK–89-4195) **LDA measurements of velocities and turbulence in a bluff body stabilized flame.** Sjunnesson, A. (Volvo Flygmotor AB, Gothenburg (Sweden)); Nelsson, C.; Max, E. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1991. 23p. Order Number DE94730439. Source: OSTI; NTIS.

LDA measurements have been performed in a premixed combustion system with bluff body flame stabilization. The LDA system was optimized to handle the temperature gradient problems in the reacting flows. An extensive amount of data has been collected for several test cases. Results are presented in diagrams and tables of velocities and turbulence parameters. The results show that the recirculation zone is larger for the reacting flow. The non-reacting flow shows a strong vortex shedding that is not present in the reacting flow.

04 OIL SHALES AND TAR SANDS

0403 Drilling, Fracturing, and Mining

6119 (DOE/MC/27246–3480) **Safer blasting agents and procedures for blasting in gassy non-coal mines: [Quarterly] technical progress report, January 1–March 31, 1993.** Weiss, E.S. Bureau of Mines, Pittsburgh, PA (United States). Pittsburgh Research Center. [1993]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI21-90MC27246. Order Number DE94002824. Source: OSTI; NTIS; GPO Dep.

The US Bureau of Mines' research program is focused on developing procedures and guidelines for acceptable underground oil shale blasting that fulfill the operational requirements for efficiency while maintaining a high level of safety when operating under gassy mine conditions. This work is aimed at providing new information, alternate methods, and innovation in underground blasting procedures. The results from this research will have direct impact on regulatory standards for blasting under gassy mine conditions. Based on the low incendivity data from the Cannon Gallery and several months of recent testing in their mine, Kennecott's Greens Creek base metal mine in Alaska had decided to exclusively use a low incendive bulk emulsion product in place of the low incendive water gel prod ct for all blasting operations. As was the case with the low incendive water gel product, the use of this bulk product resulted in: no dust ignitions and related injuries and/or production/equipment losses; the elimination if preblasting measures of using stemming and water sprays, and the improvement of roadways due to the reduction of water.

0407 Health and Safety

Refer also to citation(s) 6119

05 NUCLEAR FUELS

Refer also to citation(s) 6643, 6698, 6699, 7089, 7107

0501 Reserves, Exploration, and Mining

Refer also to citation(s) 7500

0504 Feed Processing

6120 (SR/H–666) **P Department functions and organization to July 1, 1945.** Hanford Engineer Works, Richland, WA (United States). 1 Sep 1945. 169p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. Order Number DE94004702. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The P Department has direct responsibility for the receipt of raw uranium metal, and for its processing in the 300 and 100 Areas to the point of final deliver to the Metal Storage Basins in the 200-N Area. This involves overall responsibility for all production facilities in these four Areas, including operation of the Metal Storage Buildings (303, 103), the Test Pile (Bldg. 305), and the Retention Basins (107). During plant erection, the Department provided the Construction Division with consultant and checking services. This memorandum provides a summary account of the development of the P Department, from the initiation of training at the Metallurgical Laboratory (Chicago), Clinton Laboratories, and Wilmington, to the operating basis at Hanford as of July 1, 1945. For convenience, the organizations concerned with metal fabrication (located in the 300 Area) and with pile operation (located in the 100 Areas) are considered separately. The latter is made to include the Test Pile group, although it is located in the 300 Area and, except for a few months, has reported to 300 Area supervision.

6121 (WHC-MR–0437) **A brief history of the PUREX and UO_3 facilities.** Gerber, M.S. Westinghouse Hanford Co., Richland, WA (United States). Nov 1993. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004825. Source: OSTI; NTIS; INIS; GPO Dep.

The Plutonium-Uranium Extraction (PUREX) Plant, conceived during the early Cold War years, was a vehicle to increase significantly US nuclear weapons production capacity. The original PUREX Plant was a concrete rectangle 1,005 feet long and 61.5 feet wide. The shielding capacity of the concrete was designed so that personnel in non-regulated service areas would not receive radiation in excess of 0.1 millirem per hour. This report discusses the design of the PUREX Plant, the production chronology, projects and equipment changes, equipment decontamination and reuse, waste management, and contamination events that have occurred during the operation of the plant. Additionally, the development and history of the Uranium Trioxide Plant are also covered.

0505 Uranium Enrichment

Refer also to citation(s) 6287, 7158, 7386

6122 (DOE/ER/12891–1) **Innovative lasers for uranium isotope separation: Progress report for the period September 1, 1989–May 31, 1990.** Brake, M.L.; Gilgenbach, R.M. Michigan Univ., Ann Arbor, MI (United States). Dept. of Nuclear Engineering. Jun 1990. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER12891. Order Number DE94004842. Source: OSTI; NTIS; INIS; GPO Dep.

Copper vapor lasers have important applications to uranium atomic vapor laser isotope separation (AVLIS). The authors have spent the first year of the project investigating two innovative methods of exciting/pumping copper vapor lasers which have the potential to improve the efficiency and scaling of large laser systems used in uranium isotope separation. Experimental research has focused on the laser discharge kinetics of (1) microwave and (2) electron beam excitation/pumping of large-volume copper vapor lasers. During the first year, the experiments have been designed and constructed and initial data has been taken. Highlights of some of the first year results as well as plans for the future include the following: Microwave resonant cavity produced copper vapor plasmas at 2.45 GHz, both pulsed (5 kW, 5kHz) and CW (0–500 Watts) have been investigated using heated copper chloride as the copper source. The visible emitted light has been observed and intense lines at 510.6 nm and 578.2 nm have been observed. Initial measurements of the electric field strengths have been taken with probes, the plasma volume has been measured with optical techniques, and the power has been measured with power meters. A self-consistent electromagnetic model of the cavity/plasma system which uses the above data as input shows that the copper plasma has skin depths around 100 cm, densities around 10^{12} #/cc, collisional frequencies around 10^{11}/sec., conductivities around 0.15 $(\text{Ohm-meter})^{-1}$. A simple model of the heat transfer predicts temperatures of ~900 K. All of these parameters indicate that microwave discharges may be well suited as a pump source for copper lasers. These preliminary studies will be continued during the second year with additional diagnostics added to the system to verify the model results. Chemical kinetics of the system will also be added to the model.

6123 (DOE/ER/12891–2) **Innovative lasers for uranium isotope separation: [Progress report].** Brake, M.L.; Gilgenbach, R.M. Michigan Univ., Ann Arbor, MI (United States). Dept. of Nuclear Engineering. Jun 1991. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER12891. Order Number DE94004843. Source: OSTI; NTIS; INIS; GPO Dep.

Copper vapor lasers have important applications to uranium atomic vapor laser isotope separation (AVLIS). The authors have spent the first two years of their project investigating two innovative methods of exciting/pumping copper vapor lasers which have the potential to improve the efficiency and scaling of large laser systems used in uranium isotope separation. Experimental research has focused on the laser discharge kinetics of (1) microwave, and (2) electron beam excitation/pumping of large-volume copper vapor lasers. During the first year, the experiments have been designed and constructed and initial data has been taken. During the second year these experiments have been diagnosed. Highlights of some of the second year results as well as plans for the future include the following: Microwave resonant cavity produced copper vapor plasmas at 2.45 GHz, have been investigated. A CW (0–500 W) signal heats and vaporizes the copper chloride to provide the atomic copper vapor. A pulsed (5 kW, 0.5–5kHz) signal is added to the incoming CW signal via a hybrid mixer to excite the copper states to the laser levels. An enhancement of the visible radiation has been observed during the pulsed pardon of the signal. Electrical probe measurements have been implemented on the system to verify the results of the electromagnetic model formulated last year. Laser gain measurements have been initiated with the use of a commercial copper vapor laser. Measurements of the spatial profile of the emission are also currently being made. The authors plan to increase the amount of pulsed microwave power to the system by implementing a high power magnetron. A laser cavity will be designed and added to this system.

0507 Fuels Production and Properties

Refer also to citation(s) 6623, 6690, 6691, 6692, 7008

6124 (HW–52860) **Standby status report Hot Semiworks facility.** Cooley, C.R. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 1 Sep 1957. 82p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003822. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report is written to provide information concerning the status of the Hot Semiworks facility as it is placed in stand-by on July 1, 1957. The plant was constructed in 1951 and early 1952. It vas operated on Redox type investigations until the last of 1953. The plant was then converted to the Purex flowsheet under Project CA 513 D. Operations on the Purex type investigations were started in early 1955 and continued until early in 1956. At that time a maintenance program for plant improvement and repair was initiated. This program was completed on July 1, 1957. Statements are contained in this report which pertain to the present status of physical equipment and facilities and the adequacy, operating experience, recommendations for improvement, previous work, and future considerations of the plant. However, the primary intent of the report is to provide pertinent information to personnel associated with a future start-up. For this reason, certain parts of the report are quite detailed. Only statements concerning the existing or previous state of the facility and equipment are factual. Others are opinions or experiences of plant operating personnel. Emphasis has also been placed on the faults encountered rather than the good features of the plant, in order that these faults might be corrected in the future.

6125 (KAERI/TR-268/92) **Study on the development of ADS-doped UO_2 pellet technology for high burnup nuclear fuel.** Lee, Young Woo (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Lee, Kyu Arm; Kang, Young Whan; Jung, Jin Gon; Kim, Young Suk. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). May 1992. 113p. (In Korean). Order Number DE94610791. Source: OSTI; NTIS (US Sales Only); INIS.

The ADS-doped UO_2 pellet process has been reviewed and preliminarily developed to confirm the properties of ADS-doped UO_2 pellets including average grain size and open porosity. The masterblending concept was employed to mix ADS powder with UO_2 to make good homogeneity in the mixed powder. The pellet samples were then prepared with the developed process to characterize the ADS-doped UO_2 pellet. Average grain size was increased by 2-3 μm and open porosity decreased compared to the undoped UO_2 pellet. In the study of ADS properties, ADS was decomposed at fairly low temperature and crystallized to γ- and δ-A1203. In the ADS-doped UO_2 sintering, bimodal curve was observed in sintering rate curve and no new phase formation was observed but the UO_2 peaks were shifted slightly to the high angle in the X-rays diffractogram. (Author).

6126 **Uranium chloride extraction of transuranium elements from LWR fuel.** Miller, W.E.; Ackerman, J.P.; Battles, J.E.; Johnson, T.R.; Pierce, R.D. To Dept. of Energy. 1991. U.S. patent application 7-770,386. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94003518. Source: OSTI; NTIS; GPO Dep.

A process of separating transuranium actinide values from uranium values present in spent nuclear oxide fuels containing rare earth and noble metal fission products as well as other fission products is disclosed. The oxide fuel is reduced with Ca metal in the presence of Ca chloride and a U-Fe alloy which is liquid at about 800°C to dissolve uranium metal and the noble metal fission product metals and transuranium actinide metals and rare earth fission product metals leaving Ca chloride having CaO and fission products of alkali metals and the alkali earth metals and iodine dissolved therein. The Ca chloride and CaO and the fission products contained therein are separated from the U-Fe alloy and the metal values dissolved therein. The U-Fe alloy having dissolved therein reduced metals from the spent nuclear fuel is contacted with a mixture of one or more alkali metal or alkaline earth metal halides selected from the class consisting of alkali metal or alkaline earth metal and Fe or U halide or a combination thereof to transfer transuranium actinide metals and rare earth metals to the halide salt leaving the uranium and some noble metal fission products in the U-Fe alloy and thereafter separating the halide salt and the transuranium metals dissolved therein from the U-Fe alloy and the metals dissolved therein.

6127 (SR/H–662) **Technical Department (Part I): Book 14, Operation of Hanford Engineer Works.** Hanford Engineer Works, Richland, WA (United States). 19 Jul 1945. 172p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. Order Number DE94004706. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report is a memorandum prepared for file purposes which summarizes the establishment and staffing of the Technical Department at the Hanford Engineer Works under the direction of the E.I DuPont de Nemours & Co, Inc. through July 1, 1945. It gives a picture of how the department was set up initially, grew, and evolved as more was learned about the processes under development.

6128 (SR/H–663-Del.Ver.) **S Department: Book 12, Operation of Hanford Engineer Works.** Hanford Engineer Works, Richland, WA (United States). 19 Sep 1945. 203p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. Order Number DE94004705. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This file memorandum describes the S Department's functions and organizations at the Hanford Engineer Works through July 1, 1945. The S Department has direct responsibility for the receipt of processed uranium metal from the P Department into storage at the 200-N Area, and for all subsequent processing in the two 200 Areas through the final isolation and delivery of plutonium to the Army at the Isolation Building. This involves over-all responsibility for the operation of all production and waste disposal facilities in these areas, and of the special facilities installed at the Meteorological Station (Bldg. 622) adjacent to the 200-W Area. During plant erection, the S Department provided the Construction Division with consultant and checking services in connection with the 200 Areas as a whole. This memorandum provides a summary account of the development of the S Department, from the initiation of supervision training at Clinton Laboratories up to the present complete Hanford organization. The emphasis is on supervisory personnel.

6129 (WHC-MR–0440) **Multiple missions: The 300 Area in Hanford Site history.** Gerber, M.S. Westinghouse Hanford Co., Richland, WA (United States). Sep 1993. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94005425. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides an historical overview of the role of the 300 Area buildings at the Hanford Reservation. Topics covered are: Early fuel fabrication at the Hanford site (313 and 314 Buildings); N reactor fuel fabrication in the 300 Area; 305 test pile was Hanford's first operating reactor; Early process improvement chemical research (321 and 3706 Buildings); Major 1952 and 1953 expansions in the 300 area (325 and 329 Buildings); Early 300 area facilities constructed to support reactor development (326 and 327 Buildings); Hanford site ventures with the peaceful atom (309, 308 and 318 Buildings); Modern 300 Area Buildings; Significant miscellaneous buildings in the 300 area; 300 Area process waste handling and disposal.

6130 (WSRC-MS–93-336) **Fault tree analysis of the F&H Canyon Exhaust Systems at the Savannah River Site.** Low, J.M.; Marshall, K.M. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940312–10: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001191. Source: OSTI; NTIS; GPO Dep.

The Canyon Exhaust System (CES) for the F&H Canyon chemical Separations Facilities are considered safety class items (SCIs). SCIs are defined in DOE Order 6430.1A as systems, components, and structures, including portions of process systems, whose failure could adversely affect the environment or safety and health of the public. As such, any modification to SCIs must be carefully reviewed for impact to safety. During the last year, the Savannah River Technology Center of WSRC has been requested to perform two major evolutions on the Canyon Exhaust Systems. These evaluations include an Upgrade to Canyon Exhaust System (UCES) Project for both F&H Areas and a Backfit analysis for a standby diesel generator in F-Area. The purpose of the first evaluation was to evaluate the impact of cost reduction options on the UCES reliability. The purpose of the second analysis was to provide justification for not upgrading an existing standby diesel generator to meet current safety class standards.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 6126

6131 (CONF-940143–1) **Periodic components of hand acceleration/deceleration impulses during telemanipulation.** Draper, J.V. (Oak Ridge National Lab., TN (United States)); Handel, S. Oak Ridge National Lab., TN (United States). Jan 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Society of Photo-Optical Instrumentation Engineers (SPIE) conference on teleoperation and space telerobotics; Boston, MA (United States); 15 Jan 1994. Order Number DE94003585. Source: OSTI; NTIS; INIS; GPO Dep.

Responsiveness is the ability of a telemanipulator to recreate user trajectories and impedance in time and space. For trajectory production, a key determinant of responsiveness is the ability of the system to accept user inputs, which are forces on the master handle generated by user hand acceleration/deceleration (a/d) impulses, and translate them into slave arm acceleration/deceleration. This paper presents observations of master controller a/d impulses during completion of a simple target acquisition task. Power spectral density functions (PSDF's) calculated from hand controller a/d impulses were used to assess impulse waveform. The relative contributions of frequency intervals ranging up to 25 Hz for three spatially different versions of the task were used to determine which frequencies were most important. The highest relative power was observed in frequencies between 1 Hz and 6 Hz. The key frequencies related to task difficulty were in the range from 2 Hz to 8 Hz. the results provide clues to the source of the performance inhibition.

6132 (DOE/DP–0120) **Travel to Russia to investigate Tomsk-7 explosion: Foreign trip report, June 18–29, 1993.** Gilbert, F.C. (USDOE, Washington, DC (United States)); Witmer, F.E.; Felt, R.E.; Gray, L.W.; Hyder, M.L.; Sullivan, L.H.; Wodrich, D.D. USDOE, Washington, DC (United States). Sep 1993. 83p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94000997. Source: OSTI; NTIS (US Sales Only); GPO Dep.

On April 6, 1993, at the fuel reprocessing ("radiochemical") plant of the Siberian Chemical Combine in Tomsk-7, Russia, a sequence of events occurred that caused substantial physical damage to the facility. A runaway exothermic chemical reaction occurred in a large process vessel that contained a concentrated solution of uranyl nitrate along with nitric acid, plutonium nitrate, residual fission products totaling about 560 curies, and uncertain amounts of organic constituents derived from the solvent extraction process. This reaction produced copious amounts of flammable organic and inorganic gases and steam that pressurized and burst the vessel, dislodged the concrete cell cover, and then ignited in the area immediately above the cell. The resulting explosion caused substantial damage to the crane bay above the process area, blew out several hundred feet of non-reinforced masonry wall and a section of the roof, wrecked internal components, and started small roof fires. Fortunately, the solution involved had been through one cycle of extraction and purification, so the release of activity through the stack and the openings resulted in rather low-level contamination over the area of dispersal. Because the Siberian Chemical Combine at Tomsk-7 uses the PUREX process, similar to that used at US Department of Energy (DOE) facilities, the DOE has undertaken an effort to learn the details of this accident and its causes. This led to-direct contacts with the Russian experts reported. In this document, we report our understanding of the details of this accident as obtained from the Russian experts. These were used as a basis for an investigation of DOE processing operations that have a potential for accidents of this kind.

6133 (DOE/FTR–93018110) **Travel to France to SUBWOG 30A meeting and the Third International Molten Salt Chemistry and Technology Symposium: Foreign trip report, July 8–12, 1991.** Murray, A.M. EG and G Rocky Flats, Inc., Golden, CO (United States). 6 Aug 1991. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC34-90DP62349. Order Number DE93018110. Source: OSTI; NTIS (US Sales Only); GPO Dep.

SUBWOG 30A (AWE, Reading, UK) was concerned with pyrochemical and aqueous plutonium recovery processing. Highlights of the meeting were a tour of AWE A90 Plutonium Recycle Processing Area (Bay 4) and a phase diagram discussion. The Molten Salt Chemistry and Technology symposium was held in Paris, France; papers ranged from theoretical to laboratory and production.

6134 (HW–58461) **Scope design for conversion of Purex anion exchange prototype to a manufacturing facility.** Gustafson, L.D. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 23 Jan 1959. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003755. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This document is a HAPO report dated January 23, 1959, and describes the plutonium tail-end anion exchange system, installed in Purex as a prototype unit. Although some modifications, those considered most needed, were made to the unit, additional changes and refinements were still needed to convert the prototype to a fully acceptable manufacturing facility. This document covers the scope design of these modifications. The purpose of this document is to provide scope design criteria for a project to convert the plutonium tail-end Purex Anion Exchange Prototype to a manufacturing facility.

6135 (KAERI/TR–328/92) **Process improvement of reconversion facilities.** Park, J. H. (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Chang, I. S.; Kim, E. H.; Kim, T. J.; Jeong, K. C.; Woo, M. S.; Hong, S. B.; Choi, J. H.; Chung, W. M.; Lee, K. I.; Hwang, D. S.; Kim, Y. W.; Kim, Y. K.; Choi, C. S. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jan

1993. 173p. (In Korean). Order Number DE94610197. Source: OSTI; NTIS (US Sales Only); INIS.

The project is for the development of recovery and reusing process of ammonium carbonate(AC) which is generated as a waste liquid from the reconversion facilities to reduce the manufacturing cost and the quantity of the waste liquid, and also for the development of the continuous fludized bed reaction process to promote the economics and safeties of the calcination and reduction process. In this second year report, measured the properties of AC solution and analyzed the AC concentration quantitatively. Examined the properties of AUC to investigate the properties of UO_2 powder which was converted from AUC, prepared with AC solution. Designed and installed the 2 tons-U/year pilot plant. Experimented in powder properties to set up the range of operating conditions. Modeled CFB reactor to estimate the conversion of reactor and to analyze the change of fluorine concentration to carry out the defluorination reaction. Experimented out the optimum conditions of the major operating parameters : solid circulation rate, gas velocity, solid holdup and initial inventory in cold bed to get the referential design data for hot bed. (Author).

6136 (UCRL-CR–114339) **Fire tests to evaluate the potential fire threat and its effects on HEPA filter integrity in cell ventilation at the Oak Ridge National Laboratory, Building 7920.** Hasegawa, H.K. (Oak Ridge National Lab., TN (United States)); Staggs, K.J.; Doughty, S.M. Lawrence Livermore National Lab., CA (United States); Oak Ridge National Lab., TN (United States). Dec 1992. 237p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94003621. Source: OSTI; NTIS; GPO Dep.

As a result of a DOE (Tiger Team) Technical Safety Appraisal (November 1990) of the Radiochemical Engineering Development Center (REDC), ORNL Building 7920, a number of fire protection concerns were identified. The primary concern was the perceived loss of ventilation system containment due to the thermal destruction and/or breaching of the prefilters and/or high-efficiency particulate air filters (HEPA 's) and the resultant radioactive release to the external environment. The following report describes the results of an extensive fire test program performed by the Fire Research Discipline (FRD) of the Special Projects Division of Lawrence Livermore National Lab (LLNL) and funded by ORNL to address these concerns. Full scale mock-ups of a REDC hot cell tank pit, adjacent cubicle pit, and associated ventilation system were constructed at LLNL and 13 fire experiments were conducted to specifically answer the questions raised by the Tiger Team. Our primary test plan was to characterize the burning of a catastrophic solvent spill (kerosene) of 40 liters and its effect on the containment ventilation system prefilters and HEPA filters. In conjunction with ORNL and Lockwood Greene we developed a test matrix that assessed the fire performance of the prefilters and HEPA filters; evaluated the fire response of the fiber reinforced plastic (FRP) epoxy ventilation duct work; the response and effectiveness of the fire protection system, the effect of fire in a cubicle on the vessel off-gas (VOG) elbow, and other fire safety questions.

0509 Transport, Handling, and Storage

Refer also to citation(s) 6176, 6221, 6289, 6647, 7144

0520 Waste Management

Refer also to citation(s) 6120, 6129, 6233, 6234, 6235, 6237, 6242, 6251, 6253, 6255, 6258, 6259, 6261, 6262, 6263, 6265, 6266, 6271, 6274, 6290, 6291, 6292, 6293, 6294, 6297, 6298, 6299, 6301, 6684, 6794, 7095, 7132, 7377, 7429, 7435, 7442, 7447, 7450, 7462, 7464, 7466, 7948, 7953

6137 (ANL–93/21) **Nuclear technology programs. Semiannual progress report, April–September 1991.** Argonne National Lab., IL (United States). Jul 1993. 131p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94004942. Source: OSTI; NTIS; INIS; GPO Dep.

This document reports on the work done by the Nuclear Technology Programs of the Chemical Technology Division, Argonne National Laboratory, in the period April through September 1991. These programs involve R & D in three areas: applied physical chemistry, separation science and technology, and nuclear waste management. The work in applied physical chemistry includes investigations into the processes that control the release and transport of fission products under accident-like conditions in a light water reactor, the thermophysical properties of the metal fuel in the Integral Fast Reactor, and the properties of selected materials in environments simulating those of fusion energy systems. In the area of separation science and technology, the bulk of the effort is concerned with developing and implementing processes for the removal and concentration of actinides from waste streams contaminated by transuranic elements. In the area of waste management, investigations are underway on the performance of materials in projected nuclear repository conditions to provide input to the licensing of the nation's high-level waste repositories.

6138 (ANL/CMT/CP–79205) **Stability of plutonium(VI) in WIPP brine.** Reed, D.T.; Okajima, S. Argonne National Lab., IL (United States). [1993]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931201–1: 4. international conference on chemistry and migration behavior of actinides and fission products in the geosphere, Charleston, SC (United States), 12-17 Dec 1993). Order Number DE94003714. Source: OSTI; NTIS; INIS; GPO Dep.

The redox stability of plutonium (VI) in WIPP brine was investigated by monitoring the oxidation state as a function of time using a combination of absorption spectrometry, radiochemical counting and filtration. Studies were performed with Pu-239 and Pu-238 in four WIPP brines at concentrations between 10^{-3} and 10^{-8} M for durations as long as two years. Two synthetic brines, Brine A and ERDA-6, and two underground collected brines, DH-36 and G-Seep, were used. The stability of Pu(VI) depended on the brine composition and the speciation of the plutonium in that brine. When carbonate was present, a Pu(VI)-carbonate complex was observed that was stable. In the absence of carbonate, Pu(VI) hydrolytic species predominated which had a wide range of stability in the brines investigated. The results reported will help define the speciation of plutonium in WIPP brine and hence its potential for migration.

6139 (ANL/CMT/CP–80024) **High-level waste glass compendium; what it tells us concerning the durability of borosilicate waste glass.** Cunnane, J.C. (Argonne National Lab., IL (United States)); Allison, J. Argonne National Lab., IL (United States). [1993]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931108–22: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004601. Source: OSTI; NTIS; INIS; GPO Dep.

Facilities for vitrification of high-level nuclear waste in the United States are scheduled for startup in the next few years. It is, therefore, appropriate to examine the current scientific basis for understanding the corrosion of high-level waste borosilicate glass for the range of service conditions to which the glass products from these facilities may be exposed. To this end, a document has been prepared which compiles worldwide information on borosilicate waste glass corrosion. Based on the content of this document, the acceptability of canistered waste glass for geological disposal is addressed. Waste glass corrosion in a geologic repository may be due to groundwater and/or water vapor contact. The important processes that determine the glass corrosion kinetics under these conditions are discussed based on experimental evidence from laboratory testing. Testing data together with understanding of the long-term corrosion kinetics are used to estimate radionuclide release rates. These rates are discussed in terms of regulatory performance standards.

6140 (ANL/CMT/CP–80026) **Surface layer effects on waste glass corrosion.** Feng, X. Argonne National Lab., IL (United States). [1993]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931108–19: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004572. Source: OSTI; NTIS; INIS; GPO Dep.

Water contact subjects waste glass to chemical attack that results in the formation of surface alteration layers. Two principal

hypotheses have been advanced concerning the effect of surface alteration layers on continued glass corrosion: (1) they act as a mass transport barrier and (2) they influence the chemical affinity of the glass reaction. In general, transport barrier effects have been found to be less important than affinity effects in the corrosion of most high-level nuclear waste glasses. However, they can be important under some circumstances, for example, in a very alkaline solution, in leachants containing Mg ions, or under conditions where the matrix dissolution rate is very low. The latter suggests that physical barrier effect may affect the long-term glass dissolution rate. Surface layers influence glass reaction affinity through the effects of the altered glass and secondary phases on the solution chemistry. The reaction affinity may be controlled by various precipitates and crystalline phases, amorphous silica phases, gel layer, or all the components of the glass. The surface alteration layers influence radionuclide release mainly through colloid formation, crystalline phase incorporation, and gel layer retention. This paper reviews current understanding and uncertainties.

6141 (ANL/CMT/RP–81291) **Prospects for vitrification of mixed wastes at ANL-E.** Mazer, J.; No, Hyo. Argonne National Lab., IL (United States). [1993]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94003772. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes a study evaluating the prospects for vitrification of some of the mixed wastes at ANL-E. This project can be justified on the following basis: Some of ANL-E's mixed waste streams will be stabilized such that they can be treated as a low-level radioactive waste. The expected volume reduction that results during vitrification will significantly reduce the overall waste volume requiring disposal. Mixed-waste disposal options currently used by ANL-E may not be permissible in the near future without treatment technologies such as vitrification.

6142 (BNWC–91) **Radioactive contamination in liquid waste discharged to ground at the separations facilities through December, 1964.** Wilson, R.H. Battelle-Northwest, Richland, WA (United States). Pacific Northwest Lab. 4 May 1965. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003749. Source: OSTI; NTIS; INIS; GPO Dep.

This document summarizes the amounts of radioactive contamination discharged to ground from chemical separations and laboratory facilities through December, 1964. Detailed data for individual disposal sites are presented on a month-to-month basis for the period of January through December, 1964. Previous publications of this series are listed in the bibliography and may be referred to for specific information on measurements and radioactivity totals prior to December, 1964. Several changes in crib nomenclature were made during 1964. These changes are noted on the individual tables so reference may be made to them in previous reports. Tables I and II list the major disposal sites in the separation facilities, total volume of waste discharged to each location, and the gross amounts of plutonium and beta particle emitters discharged to ground since startup. Tables III through XXIV present this same data on a monthly basis for cribs still in use, and also include information on the source of the waste stream and the settling facility if used. Isotopic data are included for disposal sites from which the waste was analyzed for specific contaminants. Estimates of contamination and volumes discharged to swamps are also included in Tables XXV and XXVI.

6143 (CEA-CONF–11534) **Prefiltration of incineration gaseous wastes by granular bed filter.** Briand, A. (CEA Centre d'Etudes de Fontenay-aux-Roses, 92 (France). Dept. de Protection de l'Environnement et des Installations); Vendel, J.; Girod, M. CEA Centre d'Etudes de Fontenay-aux-Roses, 92 (France). Dept. de Protection de l'Environnement et des Installations. 1992. 12p. (CONF-920527–: 1992 incineration conference, Albuquerque, NM (United States), 11-15 May 1992). Order Number DE94610945. Source: OSTI; NTIS (US Sales Only); INIS.

This paper presents a feasibility study of the filtration of incineration gaseous waste by means of a granular bed filter made up of a combustible material which could then itself be recycled in the incinerator. After a theoretical presentation of the granular bed filtration technique taking into account the effects of the gas temperature and the size distributions of the aerosols and the granules, results of an in-laboratory experimentation on the decontamination factor and the activity transfer during the bed combustion are presented. Then an in-situ application on a pilot incinerator of solid wastes is described.

6144 (CEA-CONF–11609) **Low level transuranic waste assay by photon interrogation and neutron counting.** Lyoussi, A. (CEA Centre d'Etudes de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Electronique et d'Instrumentation Nucleaire); Edeline, J.C.; Romeyer-Dherbey, J.; Buisson, A. CEA Centre d'Etudes de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Electronique et d'Instrumentation Nucleaire. 1993. 7p. (In English, French). (CONF-930749–: 34. annual meeting of the Institute of Nuclear Materials Management, Scottsdale, AZ (United States), 18-21 Jul 1993). Order Number DE94610950. Source: OSTI; NTIS (US Sales Only); INIS.

A comprehensive programme is currently in progress at several laboratories for the development of sensitive, practical, non destructive assay techniques for the quantification of low-level transuranics (TRU) in bulk solid wastes. This report describes the method being developed to assay high density TRU waste packages using photon interrogation. The system uses a pulsed electron beam from a linear accelerator (LINAC) to produce high-energy photon bursts from a metallic converter. The photons induce fissions in TRU. When fission is induced in trace amounts of TRU contaminants in waste material, it provides 'signatures' from fission products that can be used to assay the material before disposal. We give here the results from counting photofission-induced delayed neutrons from ^{239}Pu, ^{235}U and ^{238}U in sample matrices. We counted delayed neutrons emitted after each pulse of the LINAC. This enhances the available counts by a factor about 20 compared with the counting of delayed neutrons only after the irradiation period. The electron linear accelerator operates at 15 MeV, 140 mA, and 2.5 μs wide pulse at a 50 Hz rate. The dynamics of photofission and delayed neutron production, use of an electron linear accelerator as a particle source, experimental and electronics details, and a future experimental works are discussed. 4 refs., 8 figs., 2 tabs.

6145 (CONF-931043–6) **Molten salt oxidation of mixed wastes: Separation of radioactive materials and Resource Conservation and Recovery Act (RCRA) materials.** Bell, J.T.; Haas, P.A.; Rudolph, J.C. Oak Ridge National Lab., TN (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 8. symposium on separation science and technology for energy applications; Knoxville, TN (United States); 24-28 Oct 1993. Order Number DE94003587. Source: OSTI; NTIS; INIS; GPO Dep.

The Oak Ridge National Laboratory (ORNL) is involved in a program to apply a molten salt oxidation (MSO) process to the treatment of mixed wastes at Oak Ridge and other Department of Energy (DOE) sites. Mixed wastes are defined as those wastes that contain both radioactive components, which are regulated by the atomic energy legislation, and hazardous waste components, which are regulated under the Resource Conservation and Recovery Act (RCRA). A major part of our ORNL program involves the development of separation technologies that are necessary for the complete treatment of mixed wastes. The residues from the MSO treatment of the mixed wastes must be processed further to separate the radioactive components, to concentrate and recycle residues, or to convert the residues into forms acceptable for final disposal. This paper is a review of the MSO requirements for separation technologies, the information now available, and the concepts for our development studies.

6146 (DOE/AL/31950–T8) **Annual stability evaluation of Waste Isolation Pilot Plant.** Bureau of Mines, Washington, DC (United States). Jun 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-86AL31950. Order Number DE94005019. Source: OSTI; NTIS; INIS; GPO Dep.

A stability evaluation of the underground workings of the Waste Isolation Pilot Plant (WIPP) was completed by the US Bureau of Mines' WIPP evaluation committee. This work included a critical evaluation of the processes employed at WIPP to ensure stability,

an extensive review of available deformation measurements, a 3-day site visit, and interviews with the Department of Energy (DOE) and Westinghouse staff. General ground control processes are in place at WIPP to minimize the likelihood that major stability problems will go undetected. To increase confidence in both short- and long-term stability throughout the site (underground openings and shafts), ground stability monitoring systems, mine layout design, support systems and data analyses must be continuously improved. Such processes appear to be in place at WIPP and are discussed in this paper.

6147 (DOE/EH–0349) **Environmental management assessment of the Waste Isolation Pilot Plant (WIPP), Carlsbad, New Mexico.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). Office of Environmental Audit. Jul 1993. 192p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004708. Source: OSTI; NTIS; INIS; GPO Dep.

This document contains the results of the Environmental Management Assessment of the Waste Isolation Pilot Plant (WIPP). This Assessment was conducted by EH-24 from July 19 through July 30, 1993 to advise the Secretary of Energy of the adequacy of management systems established at WIPP to ensure the protection of the environment and compliance with Federal, state, and DOE environmental requirements. The mission of WIPP is to demonstrate the safe disposal of transuranic (TRU) waste. During this assessment, activities and records were reviewed and interviews were conducted with personnel from the management and operating contractors. This assessment revealed that WIPP's environmental safety and health programs are satisfactory, and that all levels of the Waste Isolation Division (WID) management and staff consistently exhibit a high level of commitment to achieve environmental excellence.

6148 (DOE/FTR–93018125) **Travel to France for a series of international fact-finding visits on environmental restoration and waste management: Foreign trip report, June 28–July 5, 1991.** Livingston-Behan, E. (USDOE, Washington, DC (United States)); Downing, M.; Duffy, L.; Tseng, J.; Izatt, R.D.; Oakley, D.T.; Schutte, W.; Gallagher, W.; Miller, N. USDOE Idaho Operations Office, Idaho Falls, ID (United States). 9 Sep 1991. 26p. Sponsored by USDOE, Washington, DC (United States). Order Number DE93018125. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Geographic concentration of nuclear operations, proximity to port facilities and rail, technical excellence, and a commitment to overcome institutional barriers continue to establish France as a world leader in the nuclear industry. From this base, France is undertaking an aggressive and successful nuclear waste management program. France reprocesses fuel for its own industry and for foreign customers including Japan. Current activities which are operationally advanced over those in the United States, include: (1) the decontamination and decommissioning of formerly used facilities and sites; (2) the treatment, encapsulation, vitrification and storage of a wide range of radioactive waste at Marcoule and; (3) advanced robotic manipulators designed to perform a number of remote operations at nuclear power plants (In many ways analogous to the Hanford tanks); and (4) disposal of low level wastes at the ANDRA LLW site. In particular, the delegation teamed in the recent visit to LaHague that the Vitrification Plant is operated by 85 direct personnel as compared to over 900 direct personnel projected for the operation of the Savannah River vitrification facility. As a result, the delegation is recommending a joint French/US Department of Energy system engineering study including comparisons of facility design, operating procedures, safety practices, and manpower requirements.

6149 (DOE/FTR–93018126) **Travel to French nuclear facilities to identify innovative technologies and operating practices for waste management: Foreign trip report, June 28–July 5, 1991.** Livingston-Behan, E. USDOE, Washington, DC (United States). [1991]. 18p. Sponsored by USDOE, Washington, DC (United States). Order Number DE93018126. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The purposes of this trip were to identify innovative technologies and operating practices for waste management, and to select means by which technologies could be demonstrated or directly applied at Department of Energy sites. This visit was arranged by representatives of the French Atomic Energy Agency (CEA) and its subsidiary groups. Meetings and tours were held at the following nuclear facilities: CEA and Cogema headquarters, Saclay and Fontenay-aux-Roses nuclear research establishments, Framatome-Le Creusot, Marcoule, Cadarache, La Hague, and ANDRA-Soulaines. Innovative waste management practices were identified at each of the facilities that was visited. Of particular interest were the development of robotics for remote characterization and handling of wastes, treatment and disposal of intermediate wastes (including partitioning and transmutation), and the efficient production of vitrified high-level waste. Also noted were extensive D&D operations that have been completed or are underway. For example, electric arc furnaces will be used to demonstrate the melting of contaminated steel and aluminum for reuse. Recycle limits on decontaminated metals are being negotiated between the Atomic Energy Agency and the Health Ministry.

6150 (DOE/FTR–93018760) **Travel to Japan to participate in a series of fact finding meetings and facility tours in Japan, to explore International Technologies that can be applied to US cleanup efforts: Foreign trip report, November 3–15, 1990.** Schutte, W.C. USDOE, Washington, DC (United States). [1993]. 54p. Sponsored by USDOE, Washington, DC (United States). Order Number DE93018760. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The Department of Energy Office of Environmental Restoration and Waste Management (DOE/EK participated in a series of fact finding meetings and facility tours in Japan. Meetings with Power Reactor and Nuclear Fuel Development Corporation (PNC) were conducted in accordance with the bilateral agreement between the United States Department of Energy and Power Reactor and Nuclear Fuel Development Corporation (PNC). In the opening session with Japan's Science and Technology Agency the EM delegation, led by Mr. Leo P. Duffy, jointly underscored the continuing US commitment that the technologies to be discussed would be limited to peaceful uses in the areas of environmental restoration and waste management. The delegation visited government, quasi-government and private organizations during the November 3–14, 1990, fact finding mission including the Science and Technology Agency (Tokyo), the Ministry of Trade and Industry (Tokyo, Mito, Osaka), the Power reactor and Nuclear Fuel Development Corporation (Tokyo, Tokai, Oarai, Chubu), the Japan Atomic Energy Research Institute (Tokai, Tokyo) Kyoto University, JGC Corporation (Oarai), and Kobe Steel. The delegation concludes that expanded collaboration in several technical areas described in this report appear to be of potential mutual benefit. Several areas of potential technical collaboration appear to have considerable merit in addition to successful on-going interactions related to vitrification, decommissioning, and TRU. This report provides meeting summaries and selected information on a wide range of technologies by organization.

6151 (DOE/FTR–94002802) **Travel to Japan to help JAERI scientists with design of burner reactors for nuclear waste transmutation: Foreign trip report, July 15–October 1, 1993.** Wootan, D.W. Westinghouse Hanford Co., Richland, WA (United States). 1 Nov 1993. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94002802. Source: OSTI; NTIS (US Sales Only); GPO Dep.

While at the Japanese Atomic Energy Research Institute (JAERI) as part of the JAERI Visiting Scientist Program, the JAERI concepts for advanced burner reactors (ABR) that would use minor actinide waste from commercial nuclear power plants as fuel were reviewed. JAERI currently has two ABR concepts with very hard neutron spectra, a lead cooled nitride fueled reactor, and a helium cooled nitride particle fueled reactor. Potential improvements to the JAERI concepts were investigated, including adding fission product transmutation, increasing the delayed neutron fraction, and reducing the coolant void reactivity effect when sodium coolant is used. Irradiation testing needs in support of these concepts were also discussed.

6152 (DOE/LLW–99) **DOE site performance assessment activities: Radioactive Waste Technical Support Program.** EG

and G Idaho, Inc., Idaho Falls, ID (United States); Rogers and Associates Engineering Corp., Salt Lake City, UT (United States). Jul 1990. 180p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE94005183. Source: OSTI; NTIS; INIS; GPO Dep.

Information on performance assessment capabilities and activities was collected from eight DOE sites. All eight sites either currently dispose of low-level radioactive waste (LLW) or plan to dispose of LLW in the near future. A survey questionnaire was developed and sent to key individuals involved in DOE Order 5820.2A performance assessment activities at each site. The sites surveyed included: Hanford Site (Hanford), Idaho National Engineering Laboratory (INEL), Los Alamos National Laboratory (LANL), Nevada Test Site (NTS), Oak Ridge National Laboratory (ORNL), Paducah Gaseous Diffusion Plant (Paducah), Portsmouth Gaseous Diffusion Plant (Portsmouth), and Savannah River Site (SRS). The questionnaire addressed all aspects of the performance assessment process; from waste source term to dose conversion factors. This report presents the information developed from the site questionnaire and provides a comparison of site-specific performance assessment approaches, data needs, and ongoing and planned activities. All sites are engaged in completing the radioactive waste disposal facility performance assessment required by DOE Order 5820.2A. Each site has achieved various degrees of progress and have identified a set of critical needs. Within several areas, however, the sites identified common needs and questions.

6153 (DOE/NV/11417–1) **Great Basin paleoenvironmental studies project: Technical progress report: First quarter (January–August 1993).** Nevada Univ., Reno, NV (United States). Desert Research Inst. [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC08-93NV11417. Order Number DE94004562. Source: OSTI; NTIS; INIS; GPO Dep.

Project goals, project tasks, progress on tasks, and problems encountered are described and discussed for each of the studies that make up the Great Basin Paleoenvironmental Studies Project for Yucca Mountain. These studies are: Paleobotany, Paleofauna, Geomorphology, and Transportation. Budget summaries are also given for each of the studies and for the overall project.

6154 (DOE/NV/11417–2) **Great Basin paleoenvironmental studies project: Technical progress report, second quarter, September–November, 1993.** Nevada Univ., Reno, NV (United States). Desert Research Inst. [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC08-93NV11417. Order Number DE94004563. Source: OSTI; NTIS; GPO Dep.

Progress is described in the four tasks associated with this project. Task 1, Paleobotanical studies in the Great Basin, has as its objective the reconstruction of the response of vegetation to climate in order to identify periods of mesic climate at Yucca Mountain during the last 20,000 to 50,000 years. Past extremes in infiltration rates are expected to serve as estimates of climate that may be expected during the next 10,000 years at Yucca Mtn. Task 2, Paleofaunas, will construct a history of Great Basin vertebrates that will provide empirical evidence of past environmental and climatic conditions. The objective of Task 3, Geomorphology, is to document the responses of surficial processes and landforms to the climatic changes documented by studies of packrat middens, pollen, and faunal distributions. The goal of Task 4, Transportation, is to compare the results from three models that have been suggested as appropriate for evaluating flood flows on alluvial fans with the results obtained from the traditional one-dimensional, stochastic model used in previous research for Yucca Mountain. This research looked at three alluvial fans with rail transportation alignments crossing them.

6155 (DOE/RL–93-97) **United States Department of Energy Richland Operations Office Environmental Protection Implementation Plan: November 9, 1993, to November 9, 1994.** Westinghouse Hanford Co., Richland, WA (United States). Nov 1993. 74p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94005257. Source: OSTI; NTIS; INIS; GPO Dep.

The hub of today's programs at the Hanford Site are activities dedicated to managing stored and new wastes and cleanup of waste sites. To ensure focused planning and implementing efforts for these programs, management of the site is assigned to DOE's Office of Environmental Restoration and Waste Management. This report describes policies and procedures in the following areas: Compliance activities; Environmental restoration; Waste management; and Technology development. Procedures for notification of environmental occurrences, long-range environmental protection planning and reporting, waste management programs; environmental monitoring programs, and quality assurance and data verification are also described and discussed.

6156 (DOE/WIPP–93-004) **Waste Isolation Pilot Plant, Land Management Plan.** Westinghouse Electric Corp., Carlsbad, NM (United States). Waste Isolation Div. [1993]. 68p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003508. Source: OSTI; NTIS; INIS; GPO Dep.

To reflect the requirement of section 4 of the Wastes Isolation Pilot Plant Land Withdrawal Act (the Act) (Public Law 102-579), this land management plan has been written for the withdrawal area consistent with the Federal Land Policy and Management Act of 1976. The objective of this document, per the Act, is to describe the plan for the use of the withdrawn land until the end of the decommissioning phase. The plan identifies resource values within the withdrawal area and promotes the concept of multiple-use management. The plan also provides opportunity for participation in the land use planning process by the public and local, State, and Federal agencies. Chapter 1, Introduction, provides the reader with the purpose of this land management plan as well as an overview of the Waste Isolation Pilot Plant. Chapter 2, Affected Environment, is a brief description of the existing resources within the withdrawal area. Chapter 3, Management Objectives and Planned Actions, describes the land management objectives and actions taken to accomplish these objectives.

6157 (EGG–2679(92)) **Annual report – 1992: Environmental surveillance for EG & G Idaho Waste Management Facilities at the Idaho National Engineering Laboratory.** Wilhelmsen, R.N.; Wright, K.C.; McBride, D.W. EG and G Idaho, Inc., Idaho Falls, ID (United States). Aug 1993. 107p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE94002898. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes the 1992 environmental surveillance activities of the Environmental Monitoring Unit of EG&G Idaho, Inc., at EG&G Idaho-operated Waste Management facilities at the Idaho National Engineering Laboratory (INEL). The major facilities monitored include the Radioactive Waste Management Complex, the Waste Experimental Reduction Facility, the Mixed Waste Storage Facility, and two surplus facilities. Included are some results of the sampling performed by the Radiological and Environmental Sciences Laboratory and the United States Geological Survey. The primary purposes of monitoring are to evaluate environmental conditions, to provide and interpret data, to ensure compliance with applicable regulations or standards, and to ensure protection of human health and the environment. This report compares 1992 environmental surveillance data with DOE derived concentration guides, and with data from previous years.

6158 (EGG-RAAM–10741) **Empirical distributions of radionuclides, from RWMIS data.** Atwood, C.L.; Schlafman, M.J. EG and G Idaho, Inc., Idaho Falls, ID (United States). Apr 1993. 75p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE94002896. Source: OSTI; NTIS; INIS; GPO Dep.

The RWMIS data base gives data on each shipment of waste received at the Transuranic Storage Area, including the total volume of the shipment and the activity (Ci) of each nuclide in the shipment. This report assumes that the RWMIS numbers are correct, and considers the waste containers now retrievably stored at the Transuranic Storage Area. The total decay-corrected activities are summarized for several classes, such as for transuranic (TRU) waste and non-TRU waste, for α-emitters and β/γ-emitters, by waste originator and by current storage location. The total activity for each nuclide is also given. The empirical distributions are then given for a number of classes and individual nuclides, reflecting the variability between waste shipments. They are expressed in terms of mCi/cu-ft; for fissionable nuclides, the same information is also expressed in terms of mg/cu-ft; finally, the distribution is also given

for the committed effective dose equivalent from inhalation, expressed in Mrem/cu-ft. The empirical distributions can be used for simulating the contents of a random waste container with a postulated volume. Examples are given illustrating the uses and limitations of the results.

6159 (EGG-WTD–10766) **Test plan for dig-face characterization performance testing.** Josten, N.E. EG and G Idaho, Inc., Idaho Falls, ID (United States). Sep 1993. 62p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE94002861. Source: OSTI; NTIS; INIS; GPO Dep.

The dig-face characterization concept has been under development at the Idaho National Engineering Laboratory (INEL) since FY 1992 through the support of the Buried Waste Integrated Demonstration Program. A Dig-face Characterization System conducts continuous subsurface characterization simultaneously with retrieval of hazardous and radioactive waste from buried waste sites. The system deploys multiple sensors at the retrieval operation dig-face and collects data that provide a basis for detecting, locating, and identifying hazardous conditions before they are disturbed by the retrieval equipment. This test plan describes initial efforts to test the dig-face characterization concept at the INEL Cold Test Pit using a simplified prototype apparatus and off-the-shelf sensors. The Cold Test Pit is a simulated waste site containing hazardous and radioactive waste surrogates at known locations. Testing will be directed toward three generic characterization problems: metal detection, plume detection, and radioactive source detection. The prototype apparatus will gather data using magnetometers, a ground conductivity meter, a trace gas analyzer, and a gamma ray sensor during simulated retrieval of the surrogate waste materials. The data acquired by a dig-face characterization system are unique because of the high precision, high data density, and multiple viewpoints attainable through the dig-face deployment approach. The test plan establishes procedures for collecting and validating a representative dig-face characterization data set. Analysis of these data will focus on developing criteria for predicting the depth, location, composition, and other characteristics of the surrogate waste materials. If successful, this proof-of-concept exercise will provide a foundation for future development of a fully-operational system that is capable of operating on an actual waste site.

6160 (ENEA-RT-AMB–92-03) **Leach studies: Influence of various parameters on leaching of cesium from cemented BWR evaporator concentrates.** De Angelis, G. (ENEA, Casaccia (Italy). Area Energia Ambiente e Salute); Marchetti, A.; Balzamo, S. No corporate text available. Mar 1993. 36p. (CONF-900525–5: 2. international symposium on stabilization/solidification of hazardous, radioactive and mixed waste, Williamsburg, VA (United States), 29 May - 1 jun 1990; RT/AMB–92/03). Order Number DE94727330. Source: OSTI; NTIS (US Sales Only).

The influence of different parameters on the leaching of Cesium from cemented BWR evaporator concentrates (Sulphates) was tested. In particular the variation of the following parameters was evaluated: temperature, initial concentration of the tracer, renewal and chemical composition of the leachant, size of the specimen. In a further series of tests the following effects on leaching were also taken into account: volume of leachant, addition to the mix of an air entraining agent, shorter curing times (3 days instead of 28 days), different way of carrying out the test (static, instead of dynamic conditions). Demonstration is given that only a few parameters, like temperature and chemical composition of the leachant, have some effects on leaching. A strong influence however is caused by the way used to prepare the samples, which, in general, can strongly modify the final properties of cemented waste materials.

6161 (FEMP–2297) **Fernald scrap metal recycling and beneficial reuse.** Motl, G.P.; Burns, D.D. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Oct 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-92OR21972. (CONF-931160–33: American Nuclear Society (ANS) winter meeting, San Francisco, CA (United States), 14-18 Nov 1993). Order Number DE94004018. Source: OSTI; NTIS; INIS; GPO Dep.

The Fernald site, formerly the Feed Materials Production Facility, produced uranium metal products to meet defense production requirements for the Department of Energy from 1953 to 1989. In this report is is described how the Fernald scrap metal project has demonstrated that contractor capabilities can be used successfully to recycle large quantities of Department of Energy scrap metal. The project has proven that the "beneficial reuse" concept makes excellent economic sense when a market for recycled products can be identified. Topics covered in this report include the scrap metal pile history, the procurement strategy, scrap metal processing, and a discussion of lessons learned.

6162 (GSF–15/93) **Scientific fundamentals of the repository safety in the post-charging phase for highly-radioactive wastes in a salt deposit: Results of the framework plan "Repository safety in the post-charging phase" 1989 to 1992.** Brewitz, W.; Faber, P.; Fein, E.; Heemann, U.; Kuehle, T.; Zude, F. GSF - Forschungszentrum fuer Umwelt und Gesundheit GmbH, Neuherberg (Germany); GSF - Forschungszentrum fuer Umwelt und Gesundheit GmbH, Braunschweig (Germany). Inst. fuer Tieflagerung. 1993. 139p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT KWA5901. Order Number DE94734090. Source: OSTI; NTIS (US Sales Only); INIS.

The framework plan gives an account of the current status and further, still necessary research and development work for the elaboration of scientific fundamentals and for the development of methods for the safety analysis of a future Federal radwaste repository for heat-releasing radioactive waste in salt formations. The framework plan is subdivided into a review of results and a part with project descriptions. The review of results covers the four subject areas: Scenarios and programs, chemical effects in the close-in area, geotechnical and physical effects in the close-in area, transport processes in the geosphere. (orig./HP)

6163 (GSF–22/93) **Investigations on density and seismic velocity of rock salt from the Asse mine situ and in laboratory.** Gommlich, G.; Yaramanci, U. GSF - Forschungszentrum fuer Umwelt und Gesundheit GmbH, Braunschweig (Germany). Inst. fuer Tieflagerung. 1993. 65p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT KWA5702; Foerderkennzeichen BMFT 02E8211 (GSF-TL–21/93). Order Number DE94734091. Source: OSTI; NTIS (US Sales Only); INIS.

The in situ densities of rock salt were measured with a gamma-gamma borehole probe while the seismic velocities were determined by means of a hammer-blow test. Material samples were taken from the same locations, and the densities and velocities were determined in the laboratory according to the conventionally employ methods. Values of the compensated bulk density measured in situ (2203 kg/m^3) are significantly higher than those measured in the laboratory (2176 kg/m^3). Since the laboratory methods are of great precision, the differences are exlusively attributable to strain on the sample during extraction. The spreading velocities of compression and shear waves of rock salt measured in situ lie above velocities which were measured on the samples and they are also less subject to deviation. Values of 4569 m/s were determined for compression waves and 2604 m/s for shear waves in the course of in situ measurements. The laboratory measurements on samples rendered 4435 m/s, resp. 2502 m/s. The derived parameters Young's modulus and Poisson's ratio therefore differ from the dynamic moduli determined in the laboratory (in situ: E=37.5 GPa, ν=0.258; laboratory: E=34.6 GPa, ν=0.266). The merely slight deviation of the in situ measurement values can be regarded as a criterion for the homogeneity of the rock section investigated. (orig./HP)

6164 (HW–69071) **Radioactive contamination in liquid wastes discharged to ground at separations facilities through June 1960.** Henle, R.C. Hanford Works, Richland, WA (United States). 7 Apr 1961. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003744. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This document summarizes the amounts of radioactive contamination discharged to ground from separations facilities through June 1960. Detailed data for individual disposal sites are presented

on a month-to-month basis for the period of January through June 1960. Previous publications of this series are listed in the bibliography and may be referred to for specific information on measurements and radioactivity totals prior to January 1960.

6165 (HW–72956) **Radioactive contamination in liquid wastes discharged to ground at separations facilities through December 1961.** Backman, G.E. Hanford Works, Richland, WA (United States). [1961]. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003743. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This document summarizes the amounts of radioactive contamination discharged to ground from separations facilities through December 1961. Detailed data for individual disposal sites are presented on a month-to-month basis for the period of July through December 1961. Previous publications of this series are listed in the bibliography and may be referred to for specific information on measurements and radioactivity totals prior to December 1961.

6166 (HW–81295-8) **Radioactive liquid waste disposal for August, 1964.** Wilson, R.H. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 14 Oct 1964. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94000533. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report details volumes of radioactive liquid wastes disposed of at Hanford for the month of August, 1964.

6167 (HW–81295-10) **Radioactive liquid waste disposal for October, 1964.** Wilson, R.H. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 22 Dec 1964. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003740. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report details what types and amounts of liquid wastes were disposed in the ground at Hanford in October, 1964.

6168 (K/TCD–1076) **Preconceptual design of the gas-phase decontamination demonstration cart.** Munday, E.B. Oak Ridge K-25 Site, TN (United States). Dec 1993. 47p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OT21400. Order Number DE94004841. Source: OSTI; NTIS; INIS; GPO Dep.

Removal of uranium deposits from the interior surfaces of gaseous diffusion equipment will be a major portion of the overall multibillion dollar effort to decontaminate and decommission the gaseous diffusion plants. Long-term low-temperature (LTLT) gas-phase decontamination is being developed at the K-25 Site as an in situ decontamination process that is expected to significantly lower the decontamination costs, reduce worker exposure to radioactive materials, and reduce safeguard concerns. This report documents the preconceptual design of the process equipment that is necessary to conduct a full-scale demonstration of the LTLT method in accordance with the process steps listed above. The process equipment and method proposed in this report are not intended to represent a full-scale production campaign design and operation, since the gas evacuation, gas charging, and off-gas handling systems that would be cost effective in a production campaign are not cost effective for a first-time demonstration. However, the design presented here is expected to be applicable to special decontamination projects beyond the demonstration, which could include the Deposit Recovery Program. The equipment will therefore be sized to a 200 ft size 1 converter (plus a substantial conservative design margin), which is the largest item of interest for gas phase decontamination in the Deposit Recovery Program. The decontamination equipment will allow recovery of the UF_6, which is generated from the reaction of ClF_3 with the uranium deposits, by use of NaF traps.

6169 (K/TCD–1089) **Technology needs for decommissioning and decontamination.** Bundy, R.D.; Kennerly, J.M. Oak Ridge K-25 Site, TN (United States). Dec 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OT21400. Order Number DE94004931. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes the current view of the most important decontamination and decommissioning (D & D) technology needs for the US Department of Energy facilities for which the D & D programs are the responsibility of Martin Marietta Energy Systems, Inc. The source of information used in this assessment was a survey of the D & D program managers at each facility. A summary of needs presented in earlier surveys of site needs in approximate priority order was supplied to each site as a starting point to stimulate thinking. This document reflects a brief initial assessment of ongoing needs; these needs will change as plans for D & D are finalized, some of the technical problems are solved through successful development programs, and new ideas for D and D technologies appear. Thus, this assessment should be updated and upgraded periodically, perhaps, annually. This assessment differs from others that have been made in that it directly and solely reflects the perceived need for new technology by key personnel in the D & D programs at the various facilities and does not attempt to consider the likelihood that these technologies can be successfully developed. Thus, this list of technology needs also does not consider the cost, time, and effort required to develop the desired technologies. An R & D program must include studies that have a reasonable chance for success as well as those for which there is a high need. Other studies that considered the cost and probability of successful development as well as the need for new technology are documented. However, the need for new technology may be diluted in such studies; this document focuses only on the need for new technology as currently perceived by those actually charged with accomplishing D & D.

6170 (LA–12676-MS) **Chemical composition of Hanford Tank SY-102.** Birnbaum, E.; Agnew, S.; Jarvinen, G.; Yarbro, S. Los Alamos National Lab., NM (United States). Dec 1993. 99p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003872. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy established the Tank Waste Remediation System (TWRS) to safely manage and dispose of the radioactive waste, both current and future, stored in double-shell and single-shell tanks at the Hanford sites. One major program element in TWRS is pretreatment which was established to process the waste prior to disposal using the Hanford Waste Vitrification Plant. In support of this program, Los Alamos National Laboratory has developed a conceptual process flow sheet which will remediate the entire contents of a selected double-shelled underground waste tank, including supernatant and sludge, into forms that allow storage and final disposal in a safe, cost-effective and environmentally sound manner. The specific tank selected for remediation is 241-SY-102 located in the 200 West Area. As part of the flow sheet development effort, the composition of the tank was defined and documented. This database was built by examining the history of liquid waste transfers to the tank and by performing careful analysis of all of the analytical data that have been gathered during the tank's lifetime. In order to more completely understand the variances in analytical results, material and charge balances were done to help define the chemistry of the various components in the tank. This methodology of defining the tank composition and the final results are documented in this report.

6171 (LA–12701-MS) **Tank SY-102 remediation project: Flowsheet and conceptual design report.** Yarbro, S.L.; Punjak, W.A.; Schreiber, S.B.; Dunn, S.L.; Jarvinen, G.D.; Marsh, S.F.; Pope, N.G.; Agnew, S.; Birnbaum, E.R.; Thomas, K.W.; Ortic, E.A. Los Alamos National Lab., NM (United States). Jan 1994. 114p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005243. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy established the Tank Waste Remediation System (TWRS) to safely manage and dispose of radioactive waste stored in underground tanks on the Hanford Site. A major program in TWRS is pretreatment which was established to process the waste prior to disposal. Pretreatment is needed to resolve tank safety issues and to separate wastes into high-level and low-level fractions for subsequent immobilization and disposal. There is a fixed inventory of actinides and fission products in the

tank which must be prepared for disposal. By segregating the actinides and fission products from the bulk of the waste, the tank's contents can be effectively managed. Due to the high public visibility and environmental sensitivity of this problem, real progress and demonstrated efforts toward addressing it must begin as soon as possible. As a part of this program, personnel at the Los Alamos National Laboratory (LANL) have developed and demonstrated a flowsheet to remediate tank SY-102 which is located in the 200 West Area and contains high-level radioactive waste. This report documents the results of the flowsheet demonstrations performed with simulated, but radioactive, wastes using an existing glovebox line at the Los Alamos Plutonium Facility. The tank waste was characterized using both a tank history approach and an exhaustive evaluation of the available core sample analyses. This report also presents a conceptual design complete with a working material flow model, a major equipment list, and cost estimates.

6172 (LA-UR–93-3077) **High-value use of weapons-plutonium by burning in molten salt accelerator-driven subcritical systems or reactors.** Bowman, C.D.; Venneri, F. Los Alamos National Lab., NM (United States). [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9308168–3: International seminar on planetary emergencies, Erice (Italy), 19-24 Aug 1993). Order Number DE94002641. Source: OSTI; NTIS; GPO Dep.

The application of thermal-spectrum molten-salt reactors and accelerator-driven subcritical systems to the destruction of weapons-return plutonium is considered from the perspective of deriving the maximum societal benefit. The enhancement of electric power production from burning the fertile fuel ^{232}Th with the plutonium is evaluated. Also the enhancement of destruction of the accumulated waste from commercial nuclear reactors is considered using the neutron-rich weapons plutonium. Most cases examined include the concurrent transmutation of the long-lived actinide and fission product waste (^{99}Tc, ^{129}I, ^{135}Cs, ^{126}Sn and ^{79}Se).

6173 (LA-UR–93-3424) **Hanford high level waste (HLW) tank mixer pump safe operating envelope reliability assessment.** Fischer, S.R. (Los Alamos National Lab., NM (United States)); Clark, J. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–9: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94000886. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy and its contractor, Westinghouse Corp., are responsible for the management and safe storage of waste accumulated from processing defense reactor irradiated fuels for plutonium recovery at the Hanford Site. These wastes, which consist of liquids and precipitated solids, are stored in underground storage tanks pending final disposition. Currently, 23 waste tanks have been placed on a safety watch list because of their potential for generating, storing, and periodically releasing various quantities of hydrogen and other gases. Tank 101-SY in the Hanford SY Tank Farm has been found to release hydrogen concentrations greater than the lower flammable limit (LFL) during periodic gas release events. In the unlikely event that an ignition source is present during a hydrogen release, a hydrogen burn could occur with a potential to release nuclear waste materials. To mitigate the periodic gas releases occurring from Tank 101-SY, a large mixer pump currently is being installed in the tank to promote a sustained release of hydrogen gas to the tank dome space. An extensive safety analysis (SA) effort was undertaken and documented to ensure the safe operation of the mixer pump after it is installed in Tank 101-SY.1 The SA identified a need for detailed operating, alarm, and abort limits to ensure that analyzed safety limits were not exceeded during pump operations.

6174 (LA-UR–93-3489) **PSA results for Hanford high level waste Tank 101-SY.** MacFarlane, D.R. (Los Alamos National Lab., NM (United States)); Bott, T.F.; Brown, L.F.; Stack, D.W.; Kindinger, J.; Deremer, R.K.; Medhekar, S.R.; Mikschl, T.J. Los Alamos National Lab., NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–8: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94000676. Source: OSTI; NTIS; INIS; GPO Dep.

Los Alamos National Laboratory has performed a comprehensive probabilistic safety assessment (PSA) that includes consideration of external events for the weapons-production wastes stored in tank number 241-SY-101, commonly known as Tank 101-SY, as configured in December 1992. This tank, which periodically releases ("burps") a gaseous mixture of hydrogen, nitrous oxide, ammonia, and nitrogen, was analyzed because of public safety concerns associated with the potential for release of radioactive tank contents should this gas mixture be ignited during one of the burps. In an effort to mitigate the burping phenomenon, an experiment is underway in which a large pump has been inserted into the tank to determine if pump-induced circulation of the tank contents will promote a slow, controlled release of the gases. This PSA for Tank 101-SY, which did not consider the pump experiment or future tank-remediation activities, involved three distinct tasks. First, the accident sequence analysis identified and quantified those potential accidents whose consequences result in tank material release. Second, characteristics and release paths for the airborne and liquid radioactive source terms were determined. Finally, the consequences, primarily onsite and offsite potential health effects resulting from radionuclide release, were estimated, and overall risk curves were constructed. An overview of each of these tasks and a summary of the overall results of the analysis are presented in the following sections.

6175 (LA-UR–93-4093) **Comparison of accelerator-based with reactor-based waste transmutation schemes.** Sailor, W.C.; Beard, C.A.; Venneri, F.; Davidson, J.W. Los Alamos National Lab., NM (United States). [1993]. 9p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940109–1: International conference on reactor physics and reactor compuations, Tel Aviv (Israel), 23-26 Jan 1994). Order Number DE94003942. Source: OSTI; NTIS; GPO Dep.

Accelerator-based transmutation of waste (ATW) systems for the destruction of commercial LWR spent fuel are compared with systems based on thermal reactors accomplish the same objectives. When the same technology is assumed for the actinide-burning aspect of the two systems, it is seen that the size of the accelerator is determined only by the choice of how many of the long-lived fission products to burn. if none are transmuted, then the accelerator is not necessary. This result is independent of the choice of fluid carrier, and whether the actinides are destroyed in an ATW system or in a separate reactor.

6176 (LA-UR–93-4161) **Non-invasive determination of waste drum pressurization by Acoustic Resonance Spectroscopy.** Sinha, D.N.; Kosiewicz, S.T. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931108–12: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94003935. Source: OSTI; NTIS; GPO Dep.

Preliminary work suggests that Acoustic Resonance Spectroscopy (ARS) can non-invasively determine gas pressurization of waste drums. This is done by exciting the various mechanical vibrational modes of the test drum and analyzing the characteristics of the resulting resonance frequencies and their higher harmonics. If the contained waste is a liquid, the liquid level and also some properties of the liquid including density can be determined. Additional work is needed to exploit this novel acoustic technique for noninvasive characterization of waste storage drums.

6177 (LBL–30043) **Geotechnical support and topical studies for nuclear waste geologic repositories: Annual report, fiscal year 1989.** Lawrence Berkeley Lab., CA (United States). Dec 1990. 186p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94003377. Source: OSTI; NTIS; INIS; GPO Dep.

This multidisciplinary project was initiated in fiscal year 1986. It comprises two major interrelated tasks, technical assistance and topical studies. The present report lists the technical reviews and comments made during the fiscal year 1989 and summarizes the

technical progress of the topical studies. The major task was a study of the mechanical, hydraulic, geophysical and geochemical properties of fractures in geologic rock masses. In the area of technical assistance, there were a total of 30 geotechnical support activities, including reviews of 15 study plans (SP) and participation in 5 SP Review Workshops; in-depth multidisciplinary review of 5 Exploratory Shaft Facility (ESF) Study Plans and presentation of results to DOE; preparation and revision of a white paper and proposed work statement on preclosure monitoring and performance confirmation as an outgrowth of a request made by DOE to LBL; the hosting of a DOE program review; with DOE's encouragement, preparation of 8 papers for the International High-Level Radioactive Waste Management Conference to be held in April, 1990 in Las Vegas, Nevada; and 5 instances of general technical assistance to DOE. Selected papers will be processed separately for inclusion in the Energy Science and Technology Database.

6178 (ORNL/ER–197) **Annual summary report of the Surveillance and Maintenance activities at Oak Ridge National Laboratory for FY 1993.** Oak Ridge National Lab., TN (United States); Stoller (S.M.) Corp., Oak Ridge, TN (United States). Nov 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004746. Source: OSTI; NTIS; GPO Dep.

Martin Marietta Energy Systems, Inc., manages the Oak Ridge National Laboratory (ORNL), a multipurpose research facility, for the US DOE. The ORNL Surveillance and Maintenance (S&M) Program is administered by the Environmental Restoration (ER) Program Support Section of the ORNL Waste Management and Remedial Action Division with overall management provided by the ER Program. This program was initiated for the management of former waste management and environmental research sites contaminated with radioactive materials or hazardous chemicals. The Waste Area Grouping (WAG) S&M Program manages these areas from the end of their operating life until final disposition or site stabilization in accordance with environmental regulations and best management practices. The WAG S&M Program activities for FY 1993 were conducted in five principal areas: S&M Planning; Routine S&M; Special Maintenance Projects; Project Management; and Well Plugging and Abandonment of Inactive Ground water Wells. The major accomplishment in these five areas are described.

6179 (ORNL/ER–209) **Surveillance Plan for environmental monitoring in Waste Area Grouping 6 at Oak Ridge National Laboratory, Oak Ridge, Tennessee.** Oak Ridge National Lab., TN (United States); Gilbert/Commonwealth, Inc., Knoxville, TN (United States). Dec 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004790. Source: OSTI; NTIS; INIS; GPO Dep.

This Surveillance Plan has been developed as part of the Environmental Monitoring Plan for Waste Area Grouping 6 at Oak Ridge National Laboratory, Oak Ridge, Tennessee. Environmental monitoring will be conducted in two phases: the baseline monitoring phase and the routine annual monitoring phase. The baseline monitoring phase will be conducted to establish the baseline contaminant release conditions at the Waste Area Grouping (WAG), to confirm the site-related chemicals of concern (COC), and to gather data to confirm the site hydrologic model The baseline monitoring phase is expected to begin in 1994 and continue for 12–18 months. The routine annual monitoring phase will consist of continued sampling and analyses of COC to determine off-WAG contaminant flux, to identify trends in releases, and to confirm the COC The routine annual monitoring phase will continue for ~4 years after completion of the baseline monitoring phase. This Surveillance Plan presents the technical and quality assurance surveillance activities for the various WAG 6 environmental monitoring and data evaluation plans and implementing procedures.

6180 (PNL–8659) **AREST model description.** Engel, D.W.; McGrail, B.P. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 87p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004566. Source: OSTI; NTIS; INIS; GPO Dep.

The Office of Civilian Radioactive Waste Management and the Power Reactor and Nuclear Fuel Development Corporation of Japan (PNC) have supported the development of the Analytical Repository Source-Term (AREST) at Pacific Northwest Laboratory. AREST is a computer model developed to evaluate radionuclide release from an underground geologic repository. The AREST code can be used to calculate/estimate the amount and rate of each radionuclide that is released from the engineered barrier system (EBS) of the repository. The EBS is the man-made or disrupted area of the repository. AREST was designed as a system-level models to simulate the behavior of the total repository by combining process-level models for the release from an individual waste package or container. AREST contains primarily analytical models for calculating the release/transport of radionuclides to the lost rock that surrounds each waste package. Analytical models were used because of the small computational overhead that allows all the input parameters to be derived from a statistical distribution. Recently, a one-dimensional numerical model was also incorporated into AREST, to allow for more detailed modeling of the transport process with arbitrary length decay chains. The next step in modeling the EBS, is to develop a model that couples the probabilistic capabilities of AREST with a more detailed process model. This model will need to look at the reactive coupling of the processes that are involved with the release process. Such coupling would include: (1) the dissolution of the waste form, (2) the geochemical modeling of the groundwater, (3) the corrosion of the container overpacking, and (4) the backfill material, just to name a few. Several of these coupled processes are already incorporated in the current version of AREST.

6181 (PNL–8848) **Solid Waste Projection Model: Database User's Guide: Version 1.4.** Blackburn, C.L. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003469. Source: OSTI; NTIS; INIS; GPO Dep.

The Solid Waste Projection Model (SWPM) system is an analytical tool developed by Pacific Northwest Laboratory (PNL) for Westinghouse Hanford Company (WHC) specifically to address Hanford solid waste management issues. This document is one of a set of documents supporting the SWPM system and providing instructions in the use and maintenance of SWPM components. This manual contains instructions for using Version 1.4 of the SWPM database: system requirements and preparation, entering and maintaining data, and performing routine database functions. This document supports only those operations which are specific to SWPM database menus and functions and does not Provide instruction in the use of Paradox, the database management system in which the SWPM database is established.

6182 (PNL–8853) **Software requirements specification document for the AREST code development.** Engel, D.W. (Pacific Northwest Lab., Richland, WA (United States)); McGrail, B.P.; Whitney, P.D.; Gray, W.J.; Williford, R.E.; White, M.D.; Eslinger, P.W.; Altenhofen, M.K. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004586. Source: OSTI; NTIS; INIS; GPO Dep.

The Analysis of the Repository Source Term (AREST) computer code was selected in 1992 by the U.S. Department of Energy. The AREST code will be used to analyze the performance of an underground high level nuclear waste repository. The AREST code is being modified by the Pacific Northwest Laboratory (PNL) in order to evaluate the engineered barrier and waste package designs, model regulatory compliance, analyze sensitivities, and support total systems performance assessment modeling. The current version of the AREST code was developed to be a very useful tool for analyzing model uncertainties and sensitivities to input parameters. The code has also been used successfully in supplying source-terms that were used in a total systems performance assessment. The current version, however, has been found to be inadequate for the comparison and selection of a design for the waste package. This is due to the assumptions and simplifications made in the selection of the process and system models. Thus, the new version of the AREST code will be designed to focus on the details of the individual processes and implementation of more realistic models. This document describes the requirements of the new models that

will be implemented. Included in this document is a section describing the near-field environmental conditions for this waste package modeling, description of the new process models that will be implemented, and a description of the computer requirements for the new version of the AREST code.

6183 (PNL–8967) **1993 International conference on nuclear waste management and environmental remediation, Prague, Czech Republic, September 5–11, 1993: Combined foreign trip report.** Slate, S.C. (comp.); Allen, R.E. (ed.). Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 75p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004805. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the trip was to attend the 1993 International Conference on Nuclear Waste Management and Environmental Remediation. The principal objective of this conference was to facilitate a truly international exchange of information on the management of nuclear wastes as well as contaminated facilities and sites emanating from nuclear operations. The conference was sponsored by the American Society of Mechanical Engineers, the Czech and Slovak Mechanical Engineering Societies, and the Czech and Slovak Nuclear Societies in cooperation with the Commission of the European Communities, the International Atomic Energy Agency, and the OECD Nuclear Agency. The conference was cosponsored by the American Nuclear Society, the Atomic Energy Society of Japan, the Canadian Nuclear Society, the (former USSR) Nuclear Society, and the Japan Society of Mechanical Engineers. This was the fourth in a series of biennial conferences, which started in Hong Kong, in 1987. This report summarizes shared aspects of the trip; however, each traveler's observations and recommendations are reported separately.

6184 (PNL-SA–20608) **Process chemistry for the pretreatment of Hanford tank wastes.** Lumetta, G.J. (Pacific Northwest Lab., Richland, WA (United States)); Swanson, J.L.; Barker, S.A. Pacific Northwest Lab., Richland, WA (United States). Aug 1992. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-920815–28: 204. American Chemical Society (ACS) national meeting, Washington, DC (United States), 23-28 Aug 1992). Order Number DE94004591. Source: OSTI; NTIS; INIS; GPO Dep.

Current guidelines for disposing radioactive wastes stored in underground tanks at the US Department of Energy's Hanford Site call for the vitrification of high-level waste in borosilicate glass and disposal of the glass canisters in a deep geologic repository. Low-level waste is to be cast in grout and disposed of on site in shallow burial vaults. Because of the high cost of vitrification and geologic disposal, methods are currently being developed to minimize the volume of high-level waste requiring disposal. Two approaches are being considered for pretreating radioactive tank sludges: (1) leaching of selected components from the sludge and (2) acid dissolution of the sludge followed by separation of key radionuclides. The leaching approach offers the advantage of simplicity, but the acid dissolution/radionuclide extraction approach has the potential to produce the least number of glass canisters. Four critical components (Cr, P, S, and Al) were leached from an actual Hanford tank waste-Plutonium Finishing Plant sludge. The Al, P, and S were removed from the sludge by digestion of the sludge with 0.1 M NaOH at 100°C. The Cr was leached by treating the sludge with alkaline $KMnO_4$ at 100°C. Removing these four components from the sludge will dramatically lower the number of glass canisters required to dispose of this waste. The transuranic extraction (TRUEX) solvent extraction process has been demonstrated at a bench scale using an actual Hanford tank waste. The process, which involves extraction of the transuranic elements with octyl(phenyl)-N,N-diisobutylcarbamoylmethylphosphine oxide (CMPO), separated 99.9% of the transuranic elements from the bulk components of the waste. Several problems associated with the TRUEX processing of this waste have been addressed and solved.

6185 (PNL-SA–21257) **In situ vitrification: Providing a comprehensive solution for remediation of contaminated soils.** Tixier, J.S.; Thompson, L.E. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830 ; AC05-84OR21400. (CONF-930906–16: '93 international conference on nuclear waste management and environmental remediation, Prague (Czech Republic), 5-11 Sep 1993). Order Number DE94004316. Source: OSTI; NTIS; INIS; GPO Dep.

In situ vitrification is a thermal treatment technology being developed for remediation of contaminated soils. The process transforms easily leached, contaminated soils into a leach-resistant, vitreous and crystalline monolith. The process is applicable to a wide range of soil types and conditions that include virtually any combination of radioactive, hazardous, and mixed waste contaminants. The process is currently applicable to sites that are less than 5-m deep and that do not contain sealed containers. The range of capabilities and limitations of the process is discussed in the paper. Also discussed are the results of two recent demonstrations, one a pilot-scale test on a model radioactive site at Oak Ridge, TN, the other a full-scale test on a mixed waste disposal crib at Hanford, WA. These and other successful tests have led to preparation for three near-term future demonstrations at these sites; a discussion of the plans and expectations for the demonstrations is also included in the paper.

6186 (PNL-SA–21411) **High-level waste qualification: Managing uncertainty.** Pulsipher, B.A. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930906–18: '93 international conference on nuclear waste management and environmental remediation, Prague (Czech Republic), 5-11 Sep 1993). Order Number DE94004287. Source: OSTI; NTIS; INIS; GPO Dep.

A vitrification facility is being developed by the U.S. Department of Energy (DOE) at the West Valley Demonstration Plant (WVDP) near Buffalo, New York, where approximately 300 canisters of high-level nuclear waste glass will be produced. To assure that the produced waste form is acceptable, uncertainty must be managed. Statistical issues arise due to sampling, waste variations, processing uncertainties, and analytical variations. This paper presents elements of a strategy to characterize and manage the uncertainties associated with demonstrating that an acceptable waste form product is achieved. Specific examples are provided within the context of statistical work performed by Pacific Northwest Laboratory (PNL).

6187 (PNL-SA–21839) **Control levels for residual contamination in materials considered for recycle and reuse.** Hill, R.L.; Aaberg, R.L.; Baker, D.A.; Kennedy, W.E. Jr. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930810–12: Topical meeting on environmental transport and dosimetry, Charleston, SC (United States), 31 Aug - 3 sep 1993). Order Number DE94004317. Source: OSTI; NTIS; INIS; GPO Dep.

Pacific Northwest Laboratory (PNL) is collecting data and conducting technical analyses to support joint efforts by the U.S. Department of Energy (DOE), Office of Environmental Guidance, Air, Water and Radiation Division (DOE/EH-232); by the U.S. Environmental Protection Agency (EPA); and by the U.S. Nuclear Regulatory Commission (NRC) to develop radiological control criteria for the recycle and reuse of scrap materials and equipment that contain residual radioactive contamination. The initial radiological control levels are the concentrations in or on materials considered for recycle or reuse that meet the individual (human) or industrial (electronics/film) dose criteria. The analysis identifies relevant radionuclides, potential mechanisms of exposure, and methods to determine possible non-health-related impacts from residual radioactive contamination in materials considered for recycle or reuse. The generic methodology and scenarios described here provide a basic framework for numerically deriving radiological control criteria for recycle or reuse. These will be adequately conservative for most situations.

6188 (PNL-SA–22076) **Processing constraints on high-level nuclear waste glasses for Hanford Waste Vitrification Plant.** Hrma, P.R. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930906–17: '93 international conference on nuclear waste management and environmental remediation, Prague (Czech Republic), 5-11

Sep 1993). Order Number DE94004358. Source: OSTI; NTIS; INIS; GPO Dep.

The work presented in this paper is a part of a major technology program supported by the U.S. Department of Energy (DOE) in preparation for the planned operation of the Hanford Waste Vitrification Plant (HWVP). Because composition of Hanford waste varies greatly, processability is a major concern for successful vitrification. This paper briefly surveys general aspects of waste glass processability and then discusses their ramifications for specific examples of Hanford waste streams.

6189 (PNL-SA–22122) **Logistics modeling of future solid waste storage, treatment, and disposal.** Holter, G.M.; Stiles, D.L.; Shaver, S.R.; Armacost, L.L. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9311106–2: 1993 Pacific Basin conference on hazardous waste, Honolulu, HI (United States), 8-12 Nov 1993). Order Number DE94004769. Source: OSTI; NTIS; GPO Dep.

Logistics modeling is a powerful analytical technique for effective planning of waste storage, treatment, and disposal activities. Logistics modeling facilitates analyses of alternate scenarios for future waste flows, facility schedules, and processing or handling capacities. These analyses provide an increased understanding of the specific needs for waste storage, treatment, and disposal while adequate time remains to plan accordingly. They also help to determine the sensitivity of these needs to various system parameters. This paper discusses a logistics modeling system developed by the Pacific Northwest Laboratory (PNL) to aid in solid waste planning for a large industrial complex managing many different types and classifications of waste. The basic needs for such a system are outlined, and the approach adopted in developing the system is described. A key component of this approach is the development of a conceptual model that provides a flexible framework for modeling the waste management system and addressing the range of logistics and economic issues involved. Developing an adequate description of the waste management system being analyzed is discussed. Examples are then provided of the types of analyses that have been conducted. The potential application of this modeling system to different settings is also examined.

6190 (PNL-SA–22386) **Accounting for time-varying vadose-zone water fluxes caused by infiltration caps using the MEPAS transport, exposure, and risk assessment model.** Streile, G.P.; Stroh, J.L. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931095–71: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94004592. Source: OSTI; NTIS; INIS; GPO Dep.

The Multimedia Environmental Pollutant Assessment System (MEPAS) is an objective, scientific methodology to assess and prioritize hazardous chemical and radionuclide waste disposal sites based on a limited amount of site information. The vadose zone/groundwater transport module (RADCON) of MEPAS was enhanced to simulate scenarios where water-infiltration barriers (caps) have been emplaced over contaminated sites. The computer code was modified to accommodate three periods of constant water flux through the vadose zone (i.e., flux with no cap, fully functioning cap, and partially failed cap). The simulation results from test problems where the cap should have no effect essentially duplicated the simulation results from the same test problems evaluated with the earlier (baseline) version of RADCON (which requires a single constant value of water flux). Therefore, MEPAS assessments of baseline (no-cap) scenarios should be the same as they were when the baseline RADCON code was used as the vadose zone/groundwater transport module. As expected, simulations of preliminary test problems where the cap should have an effect showed that peak concentrations arrived at the receptor later and were reduced in magnitude compared to the no-cap case. Simple criteria were derived to indicate the degree to which results could be affected by violation of the assumptions of the conceptual model. However, even when assumptions are violated, errors on the nonconservative side that could occur as the cap fails should be offset by errors on the conservative side that would have already occurred as the cap was emplaced, resulting in simulations that are conservative overall.

6191 (PNL-SA–22432) **Reaction sequences in simulated neutralized current acid waste slurry during processing with formic acid.** Smith, H.D.; Wiemers, K.D.; Langowski, M.H.; Powell, M.R.; Larson, D.E. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931195–2: International symposium on scientific basis for nuclear waste management, Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004598. Source: OSTI; NTIS; INIS; GPO Dep.

The Hanford Waste Vitrification Plant (HWVP) is being designed for the Department of Energy to immobilize high-level and transuranic wastes as glass for permanent disposal. Pacific Northwest Laboratory is supporting the HWVP design activities by conducting laboratory-scale studies using a HWVP simulated waste slurry. Conditions which affect the slurry processing chemistry were evaluated in terms of offgas composition and peak generation rate and changes in slurry composition. A standard offgas profile defined in terms of three reaction phases, decomposition of H_2CO_3, destruction of NO_2^-, and production of H_2 and NH_3 was used as a baseline against which changes were evaluated. The test variables include nitrite concentration, acid neutralization capacity, temperature, and formic acid addition rate. Results to date indicate that pH is an important parameter influencing the N_2O/NO_x generation ratio; nitrite can both inhibit and activate rhodium as a catalyst for formic acid decomposition to CO_2 and H_2; and a separate reduced metal phase forms in the reducing environment. These data are being compiled to provide a basis for predicting the HWVP feed processing chemistry as a function of feed composition and operation variables, recommending criteria for chemical adjustments, and providing guidelines with respect to important control parameters to consider during routine and upset plant operation.

6192 (PNL-SA–22505) **Application of the Ferris test methods for estimating hydraulic properties near a river boundary.** Gilmore, T.J.; Spane, F.A. Jr. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931095–75: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94004763. Source: OSTI; NTIS; GPO Dep.

Standard hydraulic test methods, such as constant-rate pumping tests, may be impractical for characterizing hazardous waste sites located near fluctuating hydrologic boundaries such as rivers or oceans. An alternate approach for hydrologic characterization at these locations is to analyze the groundwater responses associated with river-stage or tidal fluctuations to aquifer properties (i.e., hydraulic diffusivity). Based on this approach, aquifer properties were determined for an area adjoining the Columbia River on the Hanford Site using two sinusoidal analysis techniques described in Ferris (1952, 1963). The first method uses the observed groundwater time-lag response, the second uses the amplitude ratio of well water level to river stage. Both techniques assume the river fluctuations can be approximated by a sinusoidal pattern. A range for hydraulic conductivity was calculated based on the hydraulic diffusivity estimates obtained from the methods together with the known aquifer thickness (50 ft) and assumed specific yield (0.1). The analysis methods produced two overlapping hydraulic conductivity ranges, with the Ferris time-lag analysis method forming the upper bound of the range, and the Ferris well water-level/river-stage amplitude ratio method forming the lower bound. Results from a nearby standard constant-rate discharge aquifer test were also examined for comparison. These results were within the upper bound of the hydraulic conductivity range.

6193 (PNL-SA–22649) **Status of international environmental remediation activities: A report from the Prague conference.** Slate, S.C.; Thornhill, C.K.; Allen, R.E. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931095–76: Department of Energy environmental remediation conference, Augusta, GA (United

States), 24-28 Oct 1993). Order Number DE94004760. Source: OSTI; NTIS; INIS; GPO Dep.

The Prague Conference on nuclear waste management and environmental remediation provided extensive interchange of ideas and insight into new technologies and management approaches throughout the world. A variety of environmental remediation technologies have potential application to Department of Energy facilities; others illustrate pitfalls to be avoided. This paper presents the highlights from the first environmental remediation (ER) technical program in the American Society of Mechanical Engineers' series of international nuclear waste management conferences. This program covers ER technologies, decontamination and decommissioning (D&D) technologies and experience, ER site characterization and modeling, management of and results from actual clean up actions, and data on several major international environmental problems. Focusing on direct benefits to the Department of Energy's (DOE) ER Program, this paper summarizes pertinent technical information, identifies useful technical papers, lists key technical contacts, and identifies specific actions to obtain additional information. US attendance at meetings like this is normally quite limited compared to attendance at North American meetings. The purpose of this paper then is to increase general awareness of this meeting in US technical circles and to broadly disseminate key information to US ER programs and contractors. To do this, the paper is organized to present background information on the conference itself, document the beneficial technical information, and outline ongoing information exchange activities.

6194 (PNL-SA-22721) **Developing a scarifier to retrieve radioactive waste from Hanford single-shell tanks.** Bamberger, J.A. (Pacific Northwest Lab., Richland, WA (United States)); Steele, D.E. Pacific Northwest Lab., Richland, WA (United States). Aug 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9308109–2: 7. American water jet technology conference, Seattle, WA (United States), 28-31 Aug 1993). Order Number DE94004286. Source: OSTI; NTIS; INIS; GPO Dep.

Radioactive waste is stored in 149 3,785 m^3 (million gal) single-shell tanks on the US Department of Energy's Hanford Reservation in eastern Washington. To minimize leakage as the tanks age, the free liquid has been pumped out, leaving concentrated solidified salt cake and sludge deposits. Now methods to dislodge and remove this waste are being developed so that the waste can be retrieved and processed for permanent storage. This paper presents research and development on ultrahigh-pressure water-jet technology to fracture and dislodge the wastes in these tanks. A water-based prototype scarifier with an integral conveyance system is being developed, and its performance demonstrated in a coupled analytical and experimental investigation. This paper describes experimental objectives and approach and results of the single jet experiments. Previous testing indicates that the method can be readily applied to salt cake waste forms; retrieval and conveyance of sludge and viscous fluid waste forms may present additional challenges.

6195 (PNL-SA-23141) **Quantitative in situ uranium contaminant mapping using high-resolution gamma-ray spectrometry and beta scintillation counting.** Schilk, A.J.; Perkins, R.W.; Abel, K.H.; Brodzinski, R.L.; Brown, D.P.; Thompson, R.C.; Knopf, M.A. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931095–74: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94004294. Source: OSTI; NTIS; INIS; GPO Dep.

Traditional means of measuring radionuclide concentrations in soils over large areas are often time-consuming, cumbersome, expensive, and non-representative. In developing new methods for the real-time characterization of large-scale uranium contamination, three original and/or adapted technologies were demonstrated at the Fernald Environmental Management Project near Cincinnati, Ohio. The use of collimated downwell gamma-ray spectrometry, in situ surface gamma-ray spectrometry, and a novel high-energy beta scintillation sensor represents significant improvements over, and largely eliminates the need for, the collection of myriad soil samples and subsequent laboratory analyses. The results from a preliminary screening of two sites within the Fernald facility are presented here, and future versions of the beta sensor and surface gamma spectrometer are discussed in some detail.

6196 (SAND–91-2111) **Technical requirements for the actinide source-term waste test program.** Phillips, M.L.F.; Molecke, M.A. Sandia National Labs., Albuquerque, NM (United States). Oct 1993. 92p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94003676. Source: OSTI; NTIS; INIS; GPO Dep.

This document defines the technical requirements for a test program designed to measure time-dependent concentrations of actinide elements from contact-handled transuranic (CH TRU) waste immersed in brines similar to those found in the underground workings of the Waste Isolation Pilot Plant (WIPP). This test program wig determine the influences of TRU waste constituents on the concentrations of dissolved and suspended actinides relevant to the performance of the WIPP. These influences (which include pH, Eh, complexing agents, sorbent phases, and colloidal particles) can affect solubilities and colloidal mobilization of actinides. The test concept involves fully inundating several TRU waste types with simulated WIPP brines in sealed containers and monitoring the concentrations of actinide species in the leachate as a function of time. The results from this program will be used to test numeric models of actinide concentrations derived from laboratory studies. The model is required for WIPP performance assessment with respect to the Environmental Protection Agency's 40 CFR Part 191B.

6197 (SAND–92-1911) **Permeability and hydraulic diffusivity of Waste Isolation Pilot Plant repository salt inferred from small-scale brine inflow experiments.** McTigue, D.F. Sandia National Labs., Albuquerque, NM (United States). Jun 1993. 89p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94005263. Source: OSTI; NTIS; INIS; GPO Dep.

Brine seepage to 17 boreholes in salt at the Waste Isolation Pilot Plant (WIPP) facility horizon has been monitored for several years. A simple model for one-dimensional, radial, darcy flow due to relaxation of ambient pore-water pressure is applied to analyze the field data. Fits of the model response to the data yield estimates of two parameters that characterize the magnitude of the flow and the time scale over which it evolves. With further assumptions, these parameters are related to the permeability and the hydraulic diffusivity of the salt. For those data that are consistent with the model prediction, estimated permeabilities are typically 10^{-22} to 10^{-21} m^2. The relatively small range of inferred permeabilities reflects the observation that the measured seepage fluxes are fairly consistent from hole to hole, of the order of 10^{-10} m/s. Estimated diffusivities are typically 10^{-10} to 10^{-8} m^2/s. The greater scatter in inferred hydraulic diffusivities is due to the difficulty of matching the idealized model history to the observed evolution of the flows. The data obtained from several of the monitored holes are not consistent with the simple model adopted here; material properties could not be inferred in these cases.

6198 (SAND–92-7328) **A literature review of actinide-carbonate mineral interactions.** Stout, D.L. (Missouri Univ., Columbia, MO (United States). Dept. of Geological Sciences); Carroll, S.A. Sandia National Labs., Albuquerque, NM (United States). Oct 1993. 59p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94003674. Source: OSTI; NTIS; INIS; GPO Dep.

Chemical retardation of actinides in groundwater systems is a potentially important mechanism for assessing the performance of the Waste Isolation Pilot Plant (WIPP), a facility intended to demonstrate safe disposal of transuranic waste. Rigorous estimation of chemical retardation during transport through the Culebra Dolomite, a water-bearing unit overlying the WIPP, requires a mechanistic understanding of chemical reactions between dissolved elements and mineral surfaces. This report represents a first step toward this goal by examining the literature for pertinent experimental studies of actinide-carbonate interactions. A summary of existing models is given, along with the types of experiments on which these models are based. Articles pertaining to research into actinide interactions with carbonate minerals are summarized. Select articles involving trace element-carbonate mineral interactions

are also reviewed and may serve as templates for future research. A bibliography of related articles is included. Americium(III), and its nonradioactive analog neodymium(III), partition strongly from aqueous solutions into carbonate minerals. Recent thermodynamic, kinetic, and surface studies show that Nd is preferentially removed from solution, forming a Nd-Ca carbonate solid solution. Neptunium(V) is rapidly removed from solution by carbonates. Plutonium incorporation into carbonates is complicated by multiple oxidation states. Little research has been done on the radium(H) and thorium(IV) carbonate systems. Removal of uranyl ion from solution by calcite is limited to monolayer surface coverage.

6199 (SAND–93-1272C) **Results from simulated contact-handled transuranic waste experiments at the Waste Isolation Pilot Plant.** Molecke, M.A.; Sorensen, N.R.; Krumhansl, J.L. Sandia National Labs., Albuquerque, NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931108–25: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004675. Source: OSTI; NTIS; INIS; GPO Dep.

We conducted in situ experiments with nonradioactive, contact-handled transuranic (CH TRU) waste drums at the Waste Isolation Pilot Plant (WIPP) facility for about four years. We performed these tests in two rooms in rock salt, at WIPP, with drums surrounded by crushed salt or 70 wt % salt/30 wt % bentonite clay backfills, or partially submerged in a NaCl brine pool. Air and brine temperatures were maintained at ~40C. These full-scale (210-L drum) experiments provided in situ data on: backfill material moisture-sorption and physical properties in the presence of brine; waste container corrosion adequacy; and, migration of chemical tracers (nonradioactive actinide and fission product simulants) in the near-field vicinity, all as a function of time. Individual drums, backfill, and brine samples were removed periodically for laboratory evaluations. Waste container testing in the presence of brine and brine-moistened backfill materials served as a severe overtest of long-term conditions that could be anticipated in an actual salt waste repository. We also obtained relevant operational-test emplacement and retrieval experience. All test results are intended to support both the acceptance of actual TRU wastes at the WIPP and performance assessment data needs. We provide an overview and technical data summary focusing on the WIPP CH TRU enviroronmental overtests involving 174 waste drums in the presence of backfill materials and the brine pool, with posttest laboratory materials analyses of backfill sorbed-moisture content, CH TRU drum corrosion, tracer migration, and associated test observations.

6200 (SAND–93-7113C) **Solubility of Nd in brine.** Khalili, F. (Florida State Univ., Tallahassee, FL (United States). Dept. of Chemistry); Symeopoulos, V.; Chen, J.F.; Choppin, G.R. Sandia National Labs., Albuquerque, NM (United States). [1993]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931201–10: 4. international conference on chemistry and migration behavior of actinides and fission products in the geosphere, Charleston, SC (United States), 12-17 Dec 1993). Order Number DE94005099. Source: OSTI; NTIS; GPO Dep.

The solubility of Nd(III) has been measured in a synthetic brine at pcH 6.4, 8.4, 10.4 and 12.4. The brine consisted predominantly of (Na+K)Cl and $MgCl_2$, with an ionic strength of 7.8M (9.4m). The experimental solubility is much less than that estimated from modeling of the species in solution in equilibrium with the Nd solid using S.I.T. The predominant solid compound of Nd (III) at each pcH was determined from X-ray diffraction patterns.

6201 (UCRL-JC–114791) **The impact of repository heat on thermo-hydrological performance at Yucca Mountain.** Buscheck, T.A.; Nitao, J.J. Lawrence Livermore National Lab., CA (United States). Sep 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9309228–7: Focus 93: site characterization and model validation, Las Vegas, NV (United States), 26-29 Sep 1993). Order Number DE94004349. Source: OSTI; NTIS; INIS; GPO Dep.

To safely and permanently store high-level nuclear waste, the potential Yucca Mountain repository site must mitigate the release and transport of radionuclides for tens of thousands of years. In the failure scenario of greatest concern, water would contact a waste package (WP), accelerate its failure rate, and eventually transport radionuclides to the water table. These analyses have demonstrated that the only significant source of liquid water is nonequilibrium fracture flow from: (1) meteoric sources, (2) condensate drainage generated under boiling conditions, and (3) condensate drainage generated under sub-boiling conditions. The first source of liquid water arises from the ambient system; the second and third sources are generated by repository heat. Buoyant vapor flow, occurring either on a sub-repository scale or on a mountain scale, may play an important role in the generation of the second and third sources of liquid water. By considering a wide range in bulk permeability, k_b, the authors identify the threshold k_b (called k_b^{hyd}) at which buoyant, vapor convection begins to dominate hydrological behavior, and the threshold k_b (called k_b^{th}) at which this convection begins to dominate thermal behavior. They find that k_b^{th} is generally an order of magnitude larger than k_b^{hyd} and that the development of a large above-boiling zone suppresses the effects of buoyant vapor flow. Of particular concern are conditions that promote the focusing of vapor flow and condensate drainage, which could result in persistent two-phase conditions (often referred to as the heat-pipe effect) in the vicinity of WPs. The results of this study underscore the need for in situ heater tests to help diagnose the potential for the major repository-heat-driven sources of fracture flow.

6202 (USGS-OFR–92-450) **Geodetic leveling data used to define historical height changes between Tonopah Junction and Las Vegas, Nevada.** Gilmore, T.D. Geological Survey, Menlo Park, CA (United States). 1992. 133p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. Order Number DE94003605. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents geodetic leveling data for a survey route following US Highway 95 from Tonopah Junction, approximately 50 km west of Tonopah, Nevada, to Las Vegas, Nevada. The survey route passes immediately south of the potential site for a high-level nuclear waste repository at Yucca Mountain in southern Nevada. Comparisons among the results of the several repeated levelings along this survey route provide a partial basis for evaluating contemporary crustal deformation patterns in the vicinity of the Yucca Mountain site and the relation between any such deformation and geologic structures known or suspected to have been active during Quaternary time.

6203 (WHC-EP–0415-Rev.1) **Implementation plan for the Defense Nuclear Facilities Safety Board Recommendation 90-7: Revision 1.** Borsheim, G.L.; Cash, R.J.; Dukelow, G.T. Westinghouse Hanford Co., Richland, WA (United States). Dec 1992. 94p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94003873. Source: OSTI; NTIS; INIS; GPO Dep.

This document revises the original plan submitted in March 1991 for implementing the recommendations made by the Defense Nuclear Facilities Safety Board in their Recommendation 90-7 to the US Department of Energy. Recommendation 90-7 addresses safety issues of concern for 24 single-shell, high-level radioactive waste tanks containing ferrocyanide compounds at the Hanford Site. The waste in these tanks is a potential safety concern because, under certain conditions involving elevated temperatures and low concentrations of nonparticipating diluents, ferrocyanide compounds in the presence of oxidizing materials can undergo a runaway (propagating) chemical reaction. This document describes those activities underway by the Hanford Site contractor responsible for waste tank safety that address each of the six parts of Defense Nuclear Facilities Safety Board Recommendation 90-7. This document also identifies the progress made on these activities since the beginning of the ferrocyanide safety program in September 1990. Revised schedules for planned activities are also included.

6204 (WHC-EP–0474-9) **Quarterly report on Defense Nuclear Facilities Safety Board Recommendation 90-7 for the period ending June 30, 1993.** Cash, R.J.; Dukelow, G.T.; Forbes, C.J.; Meacham, J.E. Westinghouse Hanford Co., Richland, WA (United States). Oct 1993. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004824. Source: OSTI; NTIS; INIS; GPO Dep.

This is the ninth quarterly report on the progress of activities that address safety issues associated with Hanford Site high-level radioactive waste tanks containing ferrocyanide compounds. Milestones completed this quarter include (1) a report on the credibility of hot spots and a recommendation on infrared scans; (2) a document discussing the strength and limitations of proposed moisture monitoring technologies; (3) limited calibration of the neutron probe in simulant-filled drums; (4) a report interpreting data from auger surface samples of ferrocyanide tank 241-BY-104; (5) a document on the effect of possible catalyst, initiator, and diluents on ferrocyanide reactivity; (6) a report on small scale sensitivity tests of ferrocyanide flowsheet simulants; and (7) preparation and shipment of T Plant simulants for calorimetric and dryout tests.

6205 (WHC-EP–0678) **The Westinghouse Hanford Company Operational Environmental Monitoring Program CY-93.** Schmidt, J.W. Westinghouse Hanford Co., Richland, WA (United States). Oct 1993. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004895. Source: OSTI; NTIS; INIS; GPO Dep.

The Operational Environmental Monitoring Program (OEMP) provides facility-specific environmental monitoring to protect the environment adjacent to facilities under the responsibility of Westinghouse Hanford Company (WHC) and assure compliance with WHC requirements and local, state, and federal environmental regulations. The objectives of the OEMP are to evaluate: compliance with federal (DOE, EPA), state, and internal WHC environmental radiation protection requirements and guides; performance of radioactive waste confinement systems; and trends of radioactive materials in the environment at and adjacent to nuclear facilities and waste disposal sites. This paper identifies the monitoring responsibilities and current program status for each area of responsibility.

6206 (WHC-SA–1576) **Disposal of Hanford site tank wastes.** Kupfer, M.J. Westinghouse Hanford Co., Richland, WA (United States). Sep 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-920815–27: 204. American Chemical Society (ACS) national meeting, Washington, DC (United States), 23-28 Aug 1992). Order Number DE94004491. Source: OSTI; NTIS; INIS; GPO Dep.

Between 1943 and 1986, 149 single-shell tanks (SSTs) and 28 double-shell tanks (DSTs) were built and used to store radioactive wastes generated during reprocessing of irradiated uranium metal fuel elements at the U.S. Department of Energy (DOE) Hanford Site in Southeastern Washington state. The 149 SSTs, located in 12 separate areas (tank farms) in the 200 East and 200 West areas, currently contain about 1.4×10^5 m^3 of solid and liquid wastes. Wastes in the SSTs contain about 5.7×10^{18} Bq (170 MCi) of various radionuclides including ^{90}Sr, ^{99}Tc, ^{137}Cs, and transuranium (TRU) elements. The 28 DSTs also located in the 200 East and West areas contain about 9×10^4 m^3 of liquid (mainly) and solid wastes; approximately 4×10^{18}Bq (90 MCi) of radionuclides are stored in the DSTs. Important characteristics and features of the various types of SST and DST wastes are described in this paper. However, the principal focus of this paper is on the evolving strategy for final disposal of both the SST and DST wastes. Also provided is a chronology which lists key events and dates in the development of strategies for disposal of Hanford Site tank wastes. One of these strategies involves pretreatment of retrieved tank wastes to separate them into a small volume of high-level radioactive waste requiring, after vitrification, disposal in a deep geologic repository and a large volume of low-level radioactive waste which can be safely disposed of in near-surface facilities at the Hanford Site. The last section of this paper lists and describes some of the pretreatment procedures and processes being considered for removal of important radionuclides from retrieved tank wastes.

6207 (WHC-SA–2116) **Lasers for the radioactive decontamination of concrete.** Cannon, N.S.; Flesher, D.J. Westinghouse Hanford Co., Richland, WA (United States). Oct 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-931237–1: International conference on lasers and applications, Lake Tahoe, NV (United States), 6-10 Dec 1993). Order Number DE94003468. Source: OSTI; NTIS; INIS; GPO Dep.

The use of lasers for removing radioactive contamination from concrete surfaces is being investigated at the US Department of Energy's Hanford Site. A major advantage of a laser decontamination process is that no additional waste is generated. Test results using 50- and 600-W YAG (yttrium-aluminum-garnet) lasers have been extrapolated to more powerful commercially available units. The minimum removal rate for concrete in air is estimated at 420 cm^2/h (0.45 ft^2/h) to a depth of 0.64 cm (0.25 in.); underwater rates would be considerably reduced.

6208 (WHC-SA–2172) **Application of intrinsic germanium spectral gamma-ray logging for characterization of high-level nuclear waste tank leaks.** Brodeur, J.R.; Kiesler, J.P.; Kos, S.E.; Koizumi, C.J.; Nicaise, W.F.; Price, R.K. Westinghouse Hanford Co., Richland, WA (United States). Nov 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004480. Source: OSTI; NTIS; INIS; GPO Dep.

Spectral gamma-ray logging with a high-resolution, intrinsic germanium logging system was completed in boreholes surrounding two high-level nuclear waste tanks at the US Department of Energy's Hanford Site. The purpose was to characterize the concentrations of man-made radionuclides in the unsaturated zone sediments and identify any new leaks from the tanks. An intrinsic germanium detection system was used for this work because it was important to positively identify the specific radionuclides and to precisely assay those radionuclides. The spectral gamma log data were processed and displayed as log plots for each individual borehole and as three-dimensional plots of ^{137}Cs radionuclide concentrations. These data were reviewed to identify the sources of the contamination. The investigation did not uncover a new or active leak from either of the tanks. Most of the contamination found could be related to known pipeline leaks, to surface contamination from aboveground liquid spills, or to leaks from other tanks. The current spectral gamma ray data now provide a new baseline from which to compare future log data and identify any changes in the radioelement concentration.

6209 (WHC-SA–2180) **Mixed waste solidification testing on polymer and cement-based waste forms in support of Hanford's WRAP 2A facility.** Burbank, D.A. Jr.; Weingardt, K.M. Westinghouse Hanford Co., Richland, WA (United States). Oct 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-9311132–1: American Society of Testing and Materials (ASTM) symposium, Williamsburg, VA (United States), 1-5 Nov 1993). Order Number DE94003492. Source: OSTI; NTIS; INIS; GPO Dep.

A testing program has been conducted by the Westinghouse Hanford Company to confirm the baseline waste form selection for use in Waste Receiving and Processing (WRAP) Module 2A. WRAP Module 2A will provide treatment required to properly dispose of containerized contact-handled, mixed low-level waste at the US Department of Energy Hanford Site in south-central Washington State. Solidification/stabilization has been chosen as the appropriate treatment for this waste. This work is intended to test cement-based, thermosetting polymer, and thermoplastic polymer solidification media to substantiate the technology approach for WRAP Module 2A. Screening tests were performed using the major chemical constituent of each waste type to measure the gross compatibility with the immobilization media and to determine formulations for more detailed testing. Surrogate materials representing each of the eight waste types were prepared in the laboratory. These surrogates were then solidified with the selected immobilization media and subjected to a battery of standard performance tests. Detailed discussion of the laboratory work and results are contained in this report.

6210 (WHC-SD-W026-SDRD–001-Rev.3) **Supplemental design requirements document, Project W026: Revision 3.** Weidert, J.R. Westinghouse Hanford Co., Richland, WA (United States). 8 Oct 1993. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004932. Source: OSTI; NTIS; INIS; GPO Dep.

This document supplements and extends the Functional Design Criteria, SP-W026-FDC-001; for the Waste Receiving and Processing Facility (WRAP), Module 1. It provides additional detailed

requirements, summarizes key Westinghouse Hanford Company design guidance, and establishes baseline technical agreements to be used in definitive design of the WRAP-1 facility. Revision 3 of the Supplemental Design Requirements Document has been assigned an Impact Level of 3ESQ based on the content of the entire revision. The actual changes made from Revision 2 have an Impact Level of 3S and the basis for these changes was previously reviewed and approved per WHC correspondence No. 9355770.

6211 (WHC-SD-W100-ICD-001) **WRAP 2A product specification.** Parker, K.E. Westinghouse Hanford Co., Richland, WA (United States). 26 Aug 1993. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004933. Source: OSTI; NTIS; INIS; GPO Dep.

WRAP-2A will process mixed and low-level waste (MLLW) for disposal. The final treatment processes selected for use in WRAP-2A consist of stabilization using cementitious materials and immobilization using thermosetting polymers. Modifications or additions to these processes may be made as technology improvements become known. Knowledge of the diverse waste forms that must be processed will be important to the effective exploration of process technologies that may be available. This document is a compilation of the current knowledge of the waste and process methods specified for each type of waste. As the uncertainties associated with the waste and methods of processing are addressed and resolved, revisions to this document will be made. This document is broken down by feed stream, source of the waste, waste codes, radiological characterization and recommended final forms of the waste for each stream.

6212 (WSRC-MS–92-144) **Chemical pretreatment of Savannah River Site nuclear waste for disposal.** Hobbs, D.T.; Walker, D.D. Westinghouse Savannah River Co., Aiken, SC (United States). [1992]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-920815–29: 204. American Chemical Society (ACS) national meeting, Washington, DC (United States), 23-28 Aug 1992). Order Number DE94003871. Source: OSTI; NTIS; INIS; GPO Dep.

This work describes two processes, Extended Sludge Processing and In-Tank Precipitation, which have been developed and demonstrated at full-scale to pretreat the Savannah River Site High-Level Waste for permanent disposal. These processes will be carried out in waste storage tanks which have been modified for chemical processing. These processes will concentrate the radioactivity into a small volume for vitrification. The bulk of the waste will be sufficiently decontaminated such that it can be disposed of as a low-level waste. The decontaminated waste will be incorporated into a cement wasteform in the Saltstone Facility.

6213 (WSRC-MS–93-470) **Risk analysis for new nuclear waste sites: Will it generate public acceptance?.** Inhaber, H. Westinghouse Savannah River Co., Aiken, SC (United States). 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940312–39: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94002528. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses public acceptance of radioactive waste facilities and what seems to be increasingly militant stances against such facilities. The role of risk assessment in possibly enhancing public acceptance is investigated.

6214 (WSRC-MS–93-518) **Corrosion of steel in simulated nuclear waste solutions.** Mickalonis, J.I. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940222–7: Corrosion 94: National Association of Corrosion Engineers (NACE) international annual conference, Baltimore, MD (United States), 28 Feb - 4 mar 1994). Order Number DE94003856. Source: OSTI; NTIS; INIS; GPO Dep.

Processing of inhibited nuclear waste to forms for long-term storage will cause waste tank environments to have dynamic conditions. During processing compositional changes in the waste may produce a corrosive environment for the plain carbon steel tanks. Large concentrations of nitrates which corrode steel are contained in the waste. Nitrite and hydroxides are added to inhibit any corrosion. Concentration changes of nitrate and nitrite were investigated to identify corrosion regimes that may occur during processing. Corrosion testing was performed with cyclic potentiodynamic polarization and linear polarization resistance. Test samples were plain carbon steel which was similar to the material of construction of the waste tanks. The corrosion morphology of test samples was investigated by visual evaluation and scanning electron microscopy. Qualitative chemical analysis was also performed using energy dispersive spectroscopy. The corrosion mechanism changed as a function of the nitrate concentration. As the nitrate concentration was increased the steel transitioned from a passive state to general attack, and finally pitting and crevice corrosion. The nitrate anion appeared to destabilize the surface oxide. Nitrite countered the oxide breakdown, although the exact mechanism was not determined.

6215 (WSRC-MS–93-519) **Waste Tank Corrosion Program at Savannah River Site.** Chandler, J.R.; Hsu, T.C.; Hobbs, D.T.; Iyer, N.C.; Marra, J.E.; Zapp, P.E. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940222–5: Corrosion 94: National Association of Corrosion Engineers (NACE) international annual conference, Baltimore, MD (United States), 28 Feb - 4 mar 1994). Order Number DE94002940. Source: OSTI; NTIS; INIS; GPO Dep.

The Savannah River Site (SRS) has approximately 30 million gallons of high level radioactive waste stored in 51 underground tanks. SRS has maintained an active corrosion research and corrosion control and monitoring program throughout the operating history of SRS nuclear waste storage tanks. This program is largely responsible for the successful waste storage experience at SRS. The program has consisted of extensive monitoring of the tanks and surrounding environment for evidence of leaks, extensive research to understand the potential corrosion processes, and development and implementation of corrosion chemistry control. Current issues associated with waste tank corrosion are primarily focused on waste processing operations and are being addressed by a number of active programs and initiatives.

6216 (WSRC-MS–93-529) **High level radioactive waste glass production and product description.** Sproull, J.F.; Marra, S.L.; Jantzen, C.M. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-931108–8: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94003852. Source: OSTI; NTIS; INIS; GPO Dep.

This report examines borosilicate glass as a means of immobilizing high-level radioactive wastes. Borosilicate glass will encapsulate most of the defense and some of the commercial HLW in the US. The resulting waste forms must meet the requirements of the WA-SRD and the WAPS, which include a short term PCT durability test. The waste form producer must report the composition(s) of the borosilicate waste glass(es) produced but can choose the composition(s) to meet site-specific requirements. Although the waste form composition is the primary determinant of durability, the redox state of the glass; the existence, content, and composition of crystals; and the presence of glass-in-glass phase separation can affect durability. The waste glass should be formulated to avoid phase separation regions. The ultimate result of this effort will be a waste form which is much more stable and potentially less mobile than the liquid high level radioactive waste is currently.

6217 (WSRC-RP–93-941-Rev.1) **F/H seepage basin groundwater influent, effluent, precipitated sludge characterization task technical plan.** Siler, J.L. Westinghouse Savannah River Co., Aiken, SC (United States). 29 Oct 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004027. Source: OSTI; NTIS; INIS; GPO Dep.

A treatability study to support the development of a remediation system which would reduce the contaminant levels in groundwater removed from the aquifers in the vicinity of the F/H seepage basins and southwest of the Mixed Waste Management Facility (MWMF) at the Savannah River facility was conducted. Proposed changes

in the remediation system require an additional study to determine whether precipitated sludge generated from the proposed remediation system will be hazardous as defined by RCRA. Several contaminants, such as lead and mercury, are above the groundwater protection standards. The presence of radionuclides and other contaminants in the sludge does not present a problem provided that the sludge can pass the Toxicity Characteristic Leaching Procedure (TCLP) test. The study has been developed in such a manner as to cover the possible range of treatment options that may be used.

6218 (WSRC-RP–93-1177) **Task plan: Temperatures in DWPF Glass Waste Storage Building.** Hardy, B.J. Westinghouse Savannah River Co., Aiken, SC (United States). 18 Aug 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94003708. Source: OSTI; NTIS; INIS; GPO Dep.

The Bechtel National, Inc. Detailed Design Instructions for Structural Design (DDI-02) requires that concrete components of the GWSB not exceed 150°F for structural elements and 200°F locally over a 24 hour period. In addition, the Waste Acceptance Product Specifications (WAPS) sets the maximum post cooldown temperature of the glass waste-form at 400°C. Various scenarios can be postulated which result in elevated glass and concrete temperatures in the GWSB. Therefore, it is important to determine the concrete and glass temperatures during both normal and off-normal conditions. This document details specific tasks required to develop a technically defensible and verifiable methodology for determining maximum temperatures for the waste-forms and the GWSB concrete structures. All models used in this analysis will satisfy Quality Assurance requirements and be defensible to review and oversight committees.

6219 (WSRC-RP–93-1206) **Technical task plan for testing filter box sorbent-paint filter test.** Kilpatrick, L.L. Westinghouse Savannah River Co., Aiken, SC (United States). 1 Sep 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004038. Source: OSTI; NTIS; INIS; GPO Dep.

At the Savannah River Plant, High Level Waste Engineering (HLWE) asked Interim Waste Technology (IWT) to choose and test a sorbent to add to the ITP filter box that meets the EPA requirement for land disposal of containerized liquid hazardous wastes per Paint Filter Liquids (PFL) test method 9095. This report outlines the process to be used in accomplishing this task.

6220 (WSRC-RP–93-1217) **F/H seepage basin groundwater process tank settling characterization task technical plan.** Siler, J.L. Westinghouse Savannah River Co., Aiken, SC (United States). 31 Aug 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004037. Source: OSTI; NTIS; GPO Dep.

The Environmental Restoration (ER) Department is responsible for environmental remediation projects on Site at the Savannah River Plant. ER requested Interim Waste Technology Section (IWTS) to conduct a treatability study to develop a system which would reduce the ground water contaminant levels in the aquifers at the F/H seepage basins. A task technical plan has been initiated to support the remediation system development. The task plan provides the methodology for conducting further investigations into the behavior of ground water in the tanks. Potential concerns exist that are related to the settling characteristics of particulate matter in the groundwater. During periods of operation, the injection system water tank and extraction system water tank will probably maintain some minimum water level. During periods of extended treatment system downtime, ground water may remain within the injection system and extraction system water tanks. The settling of particulate matter is of potential concern due to: Radioactivity-related safety issues may need to be investigated and documented; Accumulation of particulate matter will reduce the tank's operating volumes; The characteristics of the settled particulate matter need to be determined and appropriate cleaning and/or decommission procedures developed for the tanks.

6221 (WSRC-RP–93-1260) **Particle size distribution of ground ITP washed precipitate for estimating filter box radioactive cesium release during transfer.** Kilpatrick, L.L. Westinghouse Savannah River Co., Aiken, SC (United States). 13 Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004024. Source: OSTI; NTIS; INIS; GPO Dep.

Synthetic washed ITP slurry (200 g) was oven dried for three days at 60–65°C in a pan, to a hard solid that stuck to the pan bottom. Between the cracks that formed were a few small particles of unknown size. The solids that were stuck to the pan bottom were pried free and repetitively ground in a mortar and pestle until they all passed through a 40 mesh sieve. This product was then sieved into 50, 80, 100, 170, 200, 325 sieve fractions and the results plotted. A protion of the fines passing the 325 sieve were further separated by air flotation in a glass tube with fritted bottom. Increasing amounts of air were passed up through the tube that floated out increasing fractions of particles after weighing. ITP washed precipitate, ground and dried, had a particle size distribution versus cumulative weight fraction curve between Powered coal and Filter sand. The minimum particle size was about 20 microns.

6222 (WSRC-RP–93-1304) **Nitric-phosphoric acid treatment of TRU wastes.** Smith, J.R.; Pierce, R.A.; Sturcken, E.F. Westinghouse Savannah River Co., Aiken, SC (United States). 30 Sep 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94005516. Source: OSTI; NTIS; INIS; GPO Dep.

A general process is being developed for the treatment of solid TRU and hazardous organic waste. Experimental data indicates that 100 lb/hr of aliphatic organic (plastics) and 1,000 lb/hr of non-aliphatic organic compounds can be quantitatively oxidized in a 1,000 gallon reaction vessel. The process uses dilute nitric acid in a concentrated phosphoric acid media as the main oxidant for the organic compounds. Phosphoric acid allows oxidation at temperatures up to 200°C and is relatively non-corrosive on 304-L stainless steel, especially at room temperature. Many organic materials have been completely oxidized to CO_2, CO, and inorganic acids in a 0.1M HNO_3/14.8M H_3PO_4 solution. Addition of 0.001M Pd^{2+} reduces the CO to near 1% of the released carbon gases. To accomplish complete oxidation the solution temperature must be maintained above 130–150°C. Organic materials quantitatively destroyed include neoprene, cellulose, EDTA, TBP, tartaric acid, and nitromethane. The oxidation is usually complete in a few hours for soluble organic materials. The oxidation rate for non-aliphatic organic solids is moderately fast and surface area dependent. Polyethylene is quantitatively oxidized in 1.0M HNO_3/13.8M H_3PO_4 solution while contained in pressure vessels heated with microwave energy. This is probably due to the high concentrations of NO_2· obtained in the reaction environment.

6223 (WSRC-RP–93-1378) **Identification of items and activities important to waste form acceptance by Westinghouse GoCo sites.** Plodinec, M.J. (Westinghouse Savannah River Co., Aiken, SC (United States)); Marra, S.L.; Dempster, J.; Randklev, E.H. Westinghouse Savannah River Co., Aiken, SC (United States). 12 Oct 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004435. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy has established specifications (Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms, or WAPS) for canistered waste forms produced at Hanford, Savannah River, and West Valley. Compliance with these specifications requires that each waste form producer identify the items and activities which must be controlled to ensure compliance. As part of quality assurance oversight activities, reviewers have tried to compare the methodologies used by the waste form producers to identify items and activities important to waste form acceptance. Due to the lack of a documented comparison of the methods used by each producer, confusion has resulted over whether the methods being used are consistent. This confusion has been exacerbated by different systems of nomenclature used by each producer, and the different stages of development of each project. The waste form producers have met three times in the last two years, most recently on June 28, 1993, to exchange information on each producer's program. These meetings have been sponsored

by the Westinghouse GoCo HLW Vitrification Committee. This document is the result of this most recent exchange. It fills the need for a documented comparison of the methodologies used to identify items and activities important to waste form acceptance. In this document, the methodology being used by each waste form producer is summarized, and the degree of consistency among the waste form producers is determined.

6224 (WSRC-TR–92-427-Rev.2) **Safety evaluation of the ITP filter/stripper test runs and quiet time runs using simulant solution.** Gupta, M.K. Westinghouse Savannah River Co., Aiken, SC (United States). Oct 1993. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004039. Source: OSTI; NTIS; INIS; GPO Dep.

In-Tank Precipitation is a process for removing radioactivity from the salt stored in the Waste Management Tank Farm at Savannah River. The process involves precipitation of cesium and potassium with sodium tetraphenylborate (STPB) and adsorption of strontium and actinides on insoluble sodium titanate (ST) particles. The purpose of this report is to provide the technical bases for the evaluation of Unreviewed Safety Question for the In-Tank Precipitation (ITP) Filter/Stripper Test Runs and Quiet Time Runs Program. The primary objective of the filter-stripper test runs and quiet time runs program is to ensure that the facility will fulfill its design basis function prior to the introduction of radioactive feed. Risks associated with the program are identified and include hazards, both personnel and environmental, associated with handling the chemical simulants; the presence of flammable materials; the potential for damage to the permanenet ITP and Tank Farm facilities. The risks, potential accident scenarios, and safeguards either in place or planned are discussed at length.

6225 (WSRC-TR–92-1205-Rev.1) **Bounding estimate of DWPF mercury emissions: Revision 1.** Jacobs, R.A. Westinghouse Savannah River Co., Aiken, SC (United States). 28 Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004025. Source: OSTI; NTIS; INIS; GPO Dep.

Two factors which have substantial impact on predicted Mercury emissions are the air flows in the Chemical Process Cell (CPC) and the exit temperature of the Formic Acid Vent Condenser (FAVC). The discovery in the IDMS (Integrated DWPF Melter System) of H_2 generation by noble metal catalyzed formic acid decomposition and the resultant required dilution air flow has increased the expected instantaneous CPC air flow by as much as a factor of four. In addition, IDMS has experienced higher than design (10°C) FAVC exit temperatures during certain portions of the operating cycle. These temperatures were subsequently attributed to the exothermic reaction of NO to NO_2. Moreover, evaluation of the DWPF FAVC indicated it was undersized and unless modified or replaced, routine exit temperatures would be in excess of design. Purges required for H_2 flammability control and verification of elevated FAVC exit temperatures due to NO_x reactions have lead to significant changes in CPC operating conditions. Accordingly, mercury emissions estimates have been updated based upon the new operating requirements, IDMS experience, and development of an NO_x/FAVC model which predicts FAVC exit temperatures. Using very conservative assumptions and maximum purge rates, the maximum calculated Hg emissions is approximately 130 lbs/yr. A range of 100 to 120 lbs/yr is conservatively predicted for other operating conditions. The peak emission rate calculated is 0.027 lbs/hr. The estimated DWPF Hg emissions for the construction permit are 175 lbs/yr (0.02 lbs/hr annual average).

6226 (WSRC-TR–93-316) **Tritium in the burial ground of the Savannah River Site.** Hyder, M.L. Westinghouse Savannah River Co., Aiken, SC (United States). Jun 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004902. Source: OSTI; NTIS; INIS; GPO Dep.

This memorandum reviews the available information on tritium-contaminated material discarded to burial grounds. Tritium was the first isotope studied because it represents the most immediate concern with regard to release to the environment. Substantial amounts of tritium are known to be present in the ground water underneath the area, and outcropping of this ground water in springs and seeps has been observed. The response to this release of tritium from the burial ground is a current concern. The amount of tritium emplaced in the burial ground facilities is very uncertain, however, some general conclusions can be made. In particular, most of the tritium buried is associated with spent equipment and other waste, rather than spent melts. Correspondingly, most of the tritium in the ground water seems to be associated with burials of this type, rather than the spent melts. Maps are presented showing the location of burials of tritiated waste by type, and the location of the largest individual burials according to COBRA records.

6227 (WSRC-TR–93-328) **Structural integrity evaluation of transuranic waste drums.** Gupta, N.K. Westinghouse Savannah River Co., Aiken, SC (United States). Oct 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004898. Source: OSTI; NTIS; INIS; GPO Dep.

Over 4,400 Transuranic (TRU) waste drums have been found to contain standing rain water in the drum annulus, liner, or both. This has caused some pitting corrosion damage to the inside surface of the drums. A dewatering plan is underway to inspect these drums and determine their reusability. The drums will then be stored inside the weather enclosures to mitigate the corrosion problem. The storage and any subsequent handling may extend to next 20 years until these drums are transported for final disposal at Waste Isolation Pilot Plant (WIPP). This report evaluates the loading conditions during storage and handling at SRS to ensure that these drums maintain their structural integrity. Structural analyses and fracture analyses have been performed to evaluate the storage and handling loading conditions of the drums. The analyses are based on the observation that the general corrosion will not be a concern in the weather enclosures. However, the pitting corrosion will continue to exist. Structural analyses using finite element techniques show that the drums containing 150 lbs to 800 lbs TRU waste could be safely handled under these conditions. Fracture analyses show that a drum containing 800 lbs of TRU waste could be safely handled provided a cluster of through wall corrosion pits is less than 4.0in. long. Some conclusions are derived from the drop tests performed at Sandia Labs. Drop tests at Sandia Labs were performed on new drums, however, some general observations can be made for the reusable SRS TRU drums (with some corrosion pitting) which are structurally sound and will have only limited corrosion in the future due to improved storage conditions. It is believed that the TRU drums, which have high ductility, will not fail (walls split apart) due to a postulated 10 foot drop. However, some drums which might develop localized pitting due to extended storage in the weather enclosures might fail in the event of a drop depending upon the location of corroded areas.

6228 (WSRC-TR–93-461) **Final examination of IDMS corrosion coupons.** Imrich, K.J.; Jenkins, C.F. Westinghouse Savannah River Co., Aiken, SC (United States). 16 Sep 1993. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004446. Source: OSTI; NTIS; INIS; GPO Dep.

The metallurgical examination of corrosion coupons removed from the Integrated DWPF Melter System (IDMS) was performed as part of the IDMS Materials Evaluation Program. The findings and conclusions of the evaluation program are presented in this report.

6229 (WSRC-TR–93-518) **Initial weights and dimensions of corrosion coupons installed in IDMS in August 1993.** Imrick, K. Westinghouse Savannah River Co., Aiken, SC (United States). 4 Oct 1993. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94003855. Source: OSTI; NTIS; GPO Dep.

New corrosion coupons were installed in the Feed Preparation System and the Melter/Off-Gas System of Integrated DWPF Melter System (IDMS) in August 1993. The new coupons are replacements for similar coupons which were in the IDMS since 1989 but were removed for metallurgical evaluation in April 1993. original coupons still remain on the corrosion racks in the Melter and the Off-Gas Stack. Baseline data for the replacement coupons are described in this report.

6230 (WSRC-TR–93-531) **DWPF recycle minimization: Brainstorming session.** Jacobs, R.A.; Poirier, M.R. Westinghouse Savannah River Co., Aiken, SC (United States). 12 Oct 1993. 61p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94003869. Source: OSTI; NTIS; INIS; GPO Dep.

The recycle stream from the DWPF constitutes a major source of water addition to the High Level Waste evaporator system. As now designed, the entire flow of 3.5 to 6.5 gal/min (@ 25% and 75% attainment, respectively), or 2 gal/min during idling, flow to the 2H evaporator system (Tank 43). Substantial improvement in the HLW water balance and tank volume management is expected if the DWPF recycle to the HLW evaporator system can be significantly reduced. A task team has been appointed to study alternatives for reducing the flow to the HLW evaporator system and make recommendations for implementation and/or further study and evaluation. The brainstorming session detailed in this report was designed to produce the first cut options for the task team to further evaluate.

6231 (WSRC-TR–93-564) **Ion exchange at TNX using the SKID unit.** Meyer, M.L.; Bibler, J.P. Westinghouse Savannah River Co., Aiken, SC (United States). 21 Oct 1993. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94005141. Source: OSTI; NTIS; GPO Dep.

An ion exchange unit has been manufactured for WSRC by British Nuclear Fuels, Ltd. This unit consists of three columns, ancillary valving, pumps, lines, and computer controls. It has been delivered to TNX for use in testing a cesium-specific ion exchange resin, developed at WSRC as a potential second generation process for the decontamination of Defense Waste Processing Facility (DWPF) supernate. This resin also has Department of Energy applications at both Oak Ridge and Hanford. Oak Ridge is interested in decontaminating the Melton Valley storage tank supernate, while Hanford is interested in decontaminating the 101-AW and 101-SY supernate streams. Another potential developmental interest is the Savannah River Site (SRS) DWPF recycle stream. The three primary waste streams of interest are the Oak Ridge, Hanford, and SRS, SWPF supernate streams. For these three waste streams, the cesium decontamination factor (DF) will be measured for a non-radioactive, simulated, high-level waste solution. The test objectives, process outlines, and broad characterization of the waste streams are described.

6232 (WSRC-TR–93-609) **Tank 29 salt removal method using slurry pump agitation.** Parish, W.R. Westinghouse Savannah River Co., Aiken, SC (United States). 30 Nov 1993. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004900. Source: OSTI; NTIS; INIS; GPO Dep.

This report outlines a plan for removing salt from Tank 29. The plan is based, in part, upon the experience gained in the removal of salt from Tank 19 and sludge from Tank 16. Tank 19 was the first tank in which slurry pumps were used during salt dissolution. Salt in Tank 29 will be dissolved to form a nearly saturated salt solution. The goal of Waste Removal is to remove the salt from the tank and deliver it to In-Tank Precipitation (ITP) at a concentration greater than 6.7 molar Na^+ (including dilution from transfer steam) to meet ITP requirements. (The amount of wash water used in ITP will be enough to dilute 6.7 molar Na^+ salt solution to 5 molar Na^+ required for the precipitation step). The solution will be sent to (ITP) for precipitation of soluble cesium and strontium (radioactive elements). The precipitate will be transferred to the Defense Waste Processing Facility (DWPF) for final disposal. A USQD (Unreviewed Safety Question Determination) for criticality safety issue resolution will be completed prior to salt removal.

0530 Environmental Aspects

Refer also to citation(s) 6142, 6153, 6154, 6155, 6157, 6177, 6180, 6201, 6208, 6217, 6220, 6225, 6247, 6250, 6252, 6257, 6263, 6288, 6299, 7457, 7458, 7466, 7469

6233 (AEA-CH–12) **Radioactive discharges and environmental monitoring: annual report for 1992.** AEA Technology, Harwell (United Kingdom). Jun 1993. 61p. Order Number DE94610568. Source: OSTI; NTIS (US Sales Only); INIS.

This report provides information on disposal of radioactive waste from Harwell and on associated environmental monitoring for the calendar year 1992. In most instances information has also been provided on measurements made in previous years to show the 1992 results in their historical perspective. Some new data have been included in this year's report including results from the analysis of various environmental media, such as grass, rainwater, fish and flora. In addition, there are appended sections dealing with groundwater monitoring and prescribed processes carried out under the Environmental Protection Act 1990 (EPA). The National Radiological Protection Board, (NRPB) currently recommends a primary dose limit for individual members of the public of 1 mSv per year from sources other than natural background radiation. Operations of a single site such as Harwell should give rise to a dose of no more than 0.5 mSv per year. No member of the public is judged to have exceeded this dose as a consequence of discharges made in 1992. Throughout this report discharge measurements have been assessed against derived limits corresponding to a dose of 0.5 mSv, consistent with NRPB advice. Revised atmospheric and liquid discharge authorisations granted by the Authorising Departments (HMIP and MAFF) came into effect on the 1st July 1992, replacing the previous authorisations which had been in force since the mid-1950s. Further details are given in the body of this report. (Author).

6234 (DOE/EW/50625–T12) **[Environmental Hazards Assessment Program annual report, June 1992–June 1993]: Environmental risk management Advisory Committee handbook.** Medical Univ. of South Carolina, Charleston, SC (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE94004501. Source: OSTI; NTIS; INIS; GPO Dep.

This Handbook contains information about the objectives of the Environmental Hazards Assessment Program, the make-up of the Advisory Committee and Advisory Committee procedures. Functions of the Advisory Committee are outlined, along with guidelines for meetings and establishing agendas.

6235 (DOE/WIPP–91-047C) **Fluid flow through very low permeability materials: A concern in the geological isolation of waste.** Deal, D.E. International Technology Corp., Albuquerque, NM (United States). [1992]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-86AL31950. (CONF-920307–101: Waste management '92, Tucson, AZ (United States), 1-5 Mar 1992). Order Number DE94003900. Source: OSTI; NTIS; INIS; GPO Dep.

The geological isolation of waste usually involves the selection of sites where very low permeability materials exist, but there are few earth materials that are truly impermeable. Regulatory concerns for the containment of radioactive material extend for geologic periods of time (i.e., 10,000 years or more), and it becomes nearly impossible to "assure" the behavior of the site for such long periods of time. Experience at the Waste Isolation Pilot Plant (WIPP) shows that very slow movements of fluid can take place through materials that may, in fact, have no intrinsic permeability in their undisturbed condition. Conventional hydrologic models may not be appropriate to describe flow, may provide modeling results that could be in significant variance with reality, and may not be easy to defend during the compliance process. Additionally, the very small volumes of fluid and very slow flow rates involved are difficult to observe, measure, and quantify. The WIPP disposal horizon is excavated 655 m below the surface in bedded salt of Permian age. Salt has some unique properties, but similar hydrologic problems can be expected in site investigations were other relatively impermeable beds occur, and especially in deep sites where significant overburden and confining pressures may be encountered. Innovative techniques developed during the investigations at the WIPP may find utility when investigating other disposal sites. Ongoing work at the WIPP is expected to continue to advance understanding of flow through very low permeability materials. The study of flow under these conditions will become increasingly important as additional waste disposal sites are designed that require assurance of their safety for geological periods of time.

6236 (EGG–11265-1009) **A comparison of four aerial radiological surveys of Par Pond and the surrounding area, Savannah River Site, Aiken, South Carolina: Dates of surveys: 1989–1992.** Feimster, E.L. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Remote Sensing Lab. Sep 1993. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE94004711. Source: OSTI; NTIS; INIS; GPO Dep.

A series of gamma radiation surveys was conducted over Par Pond at the Savannah River Site (SRS) in August 1993, October 1991, and August 1992 as part of an effort to monitor the radiological changes around Par Pond as its water level was lowered. The results of an April 1989 survey, which was about one-half the area of those surveys listed above, were used as baseline data for the comparison. Gamma energy spectrum analysis revealed that the only man-made gamma ray emitter detected during the four surveys in the Par Pond area was cesium-137. The comparisons revealed that: (1) significant change in the radiological environment occurred along the Par Pond shoreline as the water levels were lowered, (2) the activity in Lower Three Runs Creek varied slightly as the level/flow rate changed during the pumping process, (3) minor changes occurred in areas adjacent to the Par Pond, and (4) little or no change occurred between surveys in the spatial distribution or kind of sources detected. All changes were directly related to the moisture variations (Par Pond water lowering, rainfall, waterway flow rates) between the survey periods. The distribution, kind, and activity of sources detected beyond the pond bed were consistent between surveys. 60 figs., 14 tabs.

6237 (LA–12596-MS) **Measurement of unsaturated hydraulic conductivity and chemical transport in Yucca Mountain Tuff: Milestone Report 3044-WBS1.2.3.4.1.4.1.** Conca, J.L. (Washington State Univ., Richland, WA (United States)). Los Alamos National Lab., NM (United States). Dec 1993. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94004880. Source: OSTI; NTIS; INIS; GPO Dep.

Hydraulic conductivities, K, were experimentally determined as a function of volumetric water content, θ, in tuff from the Yucca Mountain site. In addition, the retardation factor, R_f, in Yucca Mountain tuff with respect to selenium, as the selenite species, was measured under unsaturated conditions. These data were used to determine the feasibility of applying a new unsaturated flow technology (UFA) to further hydrologic studies at Yucca Mountain. The UFA directly measures $K(\theta)$ rapidly in Yucca Mountain tuff and is shown to agree well with traditional methods. Hysteresis does not appear important during this testing. Hydraulic steady-state is achieved fastest during desaturation from a saturated state. Imbibition into dry tuff requires a long time for steady-state to occur because of slow filling of the diffusion porosity which can take a few weeks. The existing UFA is a prototype, and a new design of the next generation UFA is completed that eliminates some of the earlier problems. These preliminary investigations demonstrates that the UFA is a useful investigate technique that should be used to compliment existing techniques for hydrogeochemical characterization at Yucca Mountain and other arid sites.

6238 (PNL–8884) **Hanford Site Environmental Data for Calendar year 1992 – Ground water.** Merz, J.K.; Dresel, P.E. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 155p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004300. Source: OSTI; NTIS; INIS; GPO Dep.

This report tabulates ground-water radiological and chemical data reported for calendar year 1992 by the Ground-Water. Surveillance Project and other Pacific Northwest Laboratory (PNL) projects. The Ground-Water Surveillance Project is conducted by PNL and the Resource Conservation and Recovery Act (RCRA) Project is conducted by Westinghouse Hanford Company. This document supplements the reports Hanford Site Ground-Water Monitoring for 1992 (Dresel et al. 1993) and the Hanford Site Environmental Report for Calendar Year 1992 (Woodruff and Hanf 1993). The data listings provided here were generated from the Hanford Environmental Information System database.

6239 (PNWD–2218-HEDR-Draft) **Commercial milk distribution profiles and production locations: Hanford Environmental Dose Reconstruction Project.** Deonigi, D.E.; Anderson, D.M.; Wilfert, G.L. Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 106p. Sponsored by Department of Health and Human Services, Washington, DC (United States). DOE Contract AC06-76RL01830. Contract 200-92-0503(CDC)/18620(BNW). Order Number DE94004756. Source: OSTI; NTIS; GPO Dep.

The Hanford Environmental Dose Reconstruction (HEDR) Project was established to estimate radiation doses that people could have received from nuclear operations at the Hanford Site since 1944. For this period iodine-131 is the most important offsite contributor to radiation doses from Hanford operations. Consumption of milk from cows that ate vegetation contaminated by iodine-131 is the dominant radiation pathway for individuals who drank milk. Information has been developed on commercial milk cow locations and commercial milk distribution during 1945 and 1951. The year 1945 was selected because during 1945 the largest amount of iodine-131 was released from Hanford facilities in a calendar year; therefore, 1945 was the year in which an individual was likely to have received the highest dose. The year 1951 was selected to provide data for comparing the changes that occurred in commercial milk flows (i.e., sources, processing locations, and market areas) between World War II and the post-war period. To estimate the doses people could have received from this milk flow, it is necessary to estimate the amount of milk people consumed, the source of the milk, the specific feeding regime used for milk cows, and the amount of iodine-131 contamination deposited on feed.

6240 (PNWD–2222-HEDR-Draft) **Radionuclide releases to the atmosphere from Hanford Operations, 1944–1972: Hanford Environmental Dose Reconstruction Project.** Heeb, C.M. Pacific Northwest Lab., Richland, WA (United States). Jan 1994. 174p. Sponsored by Department of Health and Human Services, Washington, DC (United States). DOE Contract AC06-76RL01830. Contract 200-92-0503(CDC)/18620(BNW). Order Number DE94005492. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the Hanford Environmental Dose Reconstruction Project is to estimate the radiation dose that individuals could have received as a result of radionuclide emissions since 1944 from the Hanford Site. The first step in determining dose is to estimate the amount and timing of radionuclide releases to air and water. This report provides the air release information. This report provides hourly estimates of iodine-131 released to the air from separations plant operations for 1944 through 1949, the period during which sufficiently detailed release data exist to calculate hourly release estimates. Monthly release estimates for iodine-131 from 1950 through 1972 and monthly release estimates for five other radionuclides (ruthenium-103, ruthenium-106, cerium-144, strontium-90, and plutonium-239) from 1944 through 1972 are also provided in this report.

6241 (PNWD–2223-HEDR-Draft) **Radionuclide releases to the Columbia River from Hanford Operations, 1944–1971: Hanford Environmental Dose Reconstruction Project.** Heeb, C.M.; Bates, D.J. Pacific Northwest Lab., Richland, WA (United States). Jan 1994. 129p. Sponsored by Department of Health and Human Services, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94005572. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the Hanford Environmental Dose Reconstruction (HEDR) Project is to estimate the radiation dose that individuals could have received as a result of radionuclide emissions since 1944 from the Hanford Site. One source of radionuclide releases to the Columbia River was from production reactor operations. This report provides a quantitative estimate of the amount of radioactivity released each month (1944–1971) to the Columbia River from eleven radionuclides as well as from gross beta activity.

6242 (SAND–93-0429C) **Development of the FMT chemical transport simulator: Advective transport sensitivity to aqueous density and mineral volume fraction coupled to phase compositions.** Novak, C.F. Sandia National Labs., Albuquerque, NM (United States). [1993]. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931201–8: 4. international conference on chemistry and

migration behavior of actinides and fission products in the geosphere, Charleston, SC (United States), 12-17 Dec 1993). Order Number DE94005098. Source: OSTI; NTIS; INIS; GPO Dep.

The Fracture-Matrix Transport (FMT) code couples saturated porous media advection and diffusion with mechanistic chemical models for speciation and interphase reactions. FMT is being developed to support actinide solubility and retardation studies for the Waste Isolation Pilot Plant (WIPP), USDOE facility for demonstrating safe disposal of transuranic waste. Hydrologic studies of water-bearing units above the WIPP indicate double-porosity transport behavior in some locations, with groundwater concentrations ranging which potable to highly concentrated. Previously, FMT simulated such systems in two-dimensions on the continuum from advection- to diffusion-dominated, with a user-specified velocity field that allows double-porosity transport. However, aqueous density was assumed constant, and reactive minerals were assumed to occupy negligible volume. Both of these assumptions can be considered poor for evaporite systems, where large changes in porosity and aqueous density can result from high mineral solubilities. Therefore, further development of FMT has relaxed these restrictions, allowing aqueous density to vary with phase composition, and allowing void volume to change as minerals dissolve and precipitate. This paper describes the additional mathematical complexity required to simulate such systems. The sensitivity of advection-dominated transport to these variables is explored through an extended example.

6243 (SAND–93-8015) **Site environmental report for 1992.** Gordon, K.W. (ed.) (Sandia National Labs., Livermore, CA (United States)); Brekke, D.D.; Holland, R.C. Sandia National Labs., Livermore, CA (United States). [1993]. 222p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DR00789. Order Number DE94005080. Source: OSTI; NTIS; INIS; GPO Dep.

Sandia National Laboratories (SNL) is committed to conducting its operations in an environmentally safe and sound manner. It is mandatory that activities at SNL/California comply with all applicable environmental statutes, regulations, and standards. Moreover, SNL/California continuously strives to reduce risks to employees, the public, and the environment to the lowest levels reasonably possible. To help verify effective protection of public safety and preservation of the environment, SNL/California maintains an extensive, ongoing environmental monitoring program. This program, conducted in conjunction with Lawrence Livermore National Laboratory, monitors all significant airborne and liquid effluents and the general environment in the area. This monitoring effort ensures that emission controls are effective in preventing contamination of the environment. As part of the Environmental Monitoring Program, an ambient environmental surveillance system measures the possible presence of radioactive and hazardous materials in ambient air, surface water, groundwater, sewage, soil, vegetation, and locally-produced food stuffs. The program also includes an extensive environmental dosimetry program, which measures external radiation levels around the Livermore site and nearby vicinity. This executive summary focuses on impacts to the environment and estimated radiation doses to the public from site emissions.

6244 (WHC-EP–0573-1) **Westinghouse Hanford Company operational environmental monitoring annual report, CY 1992.** Schmidt, J.W.; Johnson, A.R.; McKinney, S.M.; Perkins, C.J. Westinghouse Hanford Co., Richland, WA (United States). Jul 1993. 347p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94003328. Source: OSTI; NTIS; INIS; GPO Dep.

This document presents the results of the Westinghouse Hanford Company near-facility operational environmental monitoring for 1992 in the 100, 200/600, and 300/400 Areas of the Hanford Site, in south-central Washington State in 1992. Surveillance activities included sampling and analyses of ambient air, surface water, groundwater, sediments, soil, and biota. Also, external radiation measurements and radiological surveys were taken at waste disposal sites, radiologically controlled areas, and roads. These activities were conducted to assess and to control the impacts of nuclear facilities and waste sites on the workers and the local environment. Additionally, diffuse sources were monitored to determine compliance with Federal, State, and/or local regulations. In general, although impacts from nuclear facilities are still seen on the Hanford Site and are slightly elevated when compared to offsite, these impacts are less than in previous years.

6245 (WHC-EP–0689) **Services provided by the 222-S laboratory for regulatory support.** Thomas, S.P. Westinghouse Hanford Co., Richland, WA (United States). Nov 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004894. Source: OSTI; NTIS; INIS; GPO Dep.

This document defines the services the 222-S Laboratory shall provide Regulatory Support (RS) and the samples RS plans to submit to the 222-S Laboratory throughout the calendar year for analysis. Analysis of effluent (liquid and air discharges) and environmental (air, liquid, animal, and vegetative) samples is required using standard laboratory procedures, in accordance with regulatory and control requirements cited in Quality Assurance Program Plan for Radionuclide Airborne Emissions Monitoring, Quality Assurance Project Plan for Facility Effluent Monitoring Plan Activities, and Operational Environmental Monitoring Program Quality Assurance Project Plan. Radionuclide air emissions from the Hanford Site and the resulting effective dose equivalent to any member of the public from those emissions are reported. This report complies with the reporting requirements of the Code of Federal Regulations, Title 40, "Protection of the Environment, " Part 61, "National Emissions Standards for Hazardous Air Pollutants, " Subpart H, "National Emission Standards for Emissions of Radionuclide Other Than Radon From Department of Energy Facilities."

6246 (WHC-SA–1907) **Assessment of unsaturated zone radionuclide contamination in the 200 areas of the Hanford site, Washington.** Brodeur, J.R.; Wittreich, C.D. Westinghouse Hanford Co., Richland, WA (United States). Mar 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-9304117–5: International waste management conference, San Juan (Puerto Rico), 28 Apr - 1 may 1993). Order Number DE94004484. Source: OSTI; NTIS; INIS; GPO Dep.

The 200 East and 200 West Areas at the Department of Energy's Hanford site in southeastern Washington, contain chemical and nuclear fuel processing facilities that disposed of large volumes of chemical and radionuclide effluents to the ground via various structures such as ponds, cribs and ditches. A geophysical logging investigation was implemented in 1992 to assess the nature and extent of contamination beneath select liquid disposal sites in the 200 Areas. The borehole geophysical logging was accomplished with a recently developed spectral gamma-ray logging system called the Radionuclide Logging System (RLS). This system has a high-resolution, intrinsic germanium detector mounted in a downhole probe and is calibrated and operated specifically for use in a borehole environment. It provides a means to develop in-situ, gamma-emitting radioelement concentration profiles. Approximately 50 boreholes were logged in this study. The RLS log data provided information about the migration and deposition patterns of specific radionuclides in the unsaturated zone and their impacts on the groundwater. Approximately 10 radionuclide species were detected and quantified. Results of the field investigation are being used to refine site specific conceptual models, support Hanford Site remediation decisions and focus future characterization activities.

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Refer also to citation(s) 6132, 6136, 6147, 6148, 6150, 6155, 6157, 6171, 6173, 6178, 6179, 6183, 6184, 6187, 6193, 6195, 6203, 6204, 6205, 6206, 6207, 6217, 6220, 6222, 6224, 6225, 6226, 6227, 6234, 6244, 6246, 6719, 6769, 7383, 7429, 7442, 7454, 7460, 7464, 7466, 7507, 7902

6247 (ANL/CMT/CP–79780) **Distribution of uranium-bearing phases in soils from Fernald.** Buck, E.C.; Brown, N.R.; Dietz, N.L. Argonne National Lab., IL (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931108–15: Fall meeting of the Materials Research Society (MRS), Boston, MA (United

States), 29 Nov - 3 dec 1993). Order Number DE94004576. Source: OSTI; NTIS; INIS; GPO Dep.

Electron beam techniques have been used to characterize uranium-contaminated soils and the Fernald Site, Ohio. Uranium particulates have been deposited on the soil through chemical spills and from the operation of an incinerator plant on the site. The major uranium phases have been identified by electron microscopy as uraninite, autunite, and uranium phosphite [$U(PO_3)_4$]. Some of the uranium has undergone weathering resulting in the redistribution of uranium within the soil.

6248 (ANL/EA/CP–79884) **Significance of radon exposures in developing cleanup criteria for radium-contaminated soil at the Weldon Spring Site.** Blunt, D.L. (Argonne National Lab., IL (United States)); Peterson, J.M.; Hillman, D.J. Argonne National Lab., IL (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931095–64: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94003213. Source: OSTI; NTIS; INIS; GPO Dep.

The Weldon Spring site, located in St. Charles County, Missouri, is included on the National Priorities List (NPL) of the US Environmental Protection Agency (EPA), and the US Department of Energy (DOE) is currently conducting cleanup activities at the site. This paper discusses the significance of radon exposures that may result from radium-contaminated soil and the approach currently being taken at the Weldon Spring site to address this issue.

6249 (ANL/EA/CP–79945) **The evolution of risk communication at the Weldon Spring site.** McCracken, S. (USDOE Weldon Spring Site, St. Charles, MO (United States)); Sizemore, M.; Meyer, L.; MacDonell, M.; Haroun, L. Argonne National Lab., IL (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931095–63: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94003214. Source: OSTI; NTIS; INIS; GPO Dep.

Clear risk communication is one of the keys to establishing a positive relationship with the public at an environmental restoration site. This effort has been evolving at the Weldon Spring site over the past few years, with considerable input from the local community. The recent signing of the major cleanup decision for this site, which identifies on-site disposal as the remedy reflects the strength of the communication program that has evolved for the project.

6250 (CONF-931043–7) **Secondary wastes and treatment of effluents from leaching of uranium from soils.** Ally, M.R.; Wilson, J.H.; Francis, C.W. Oak Ridge National Lab., TN (United States). [1993]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 8. symposium on separation science and technology for energy applications; Knoxville, TN (United States); 24-28 Oct 1993. Order Number DE94004245. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy's Feed Materials and Production Center at Fernald, Ohio has over two million cubic meters of soil contaminated with Uranium which must be cleaned. Soil characterization studies show that Uranium is unevenly distributed between the clay, sand and silt fractions. This paper examines the option of using leaching agents to remove Uranium from the soil and the treatment of secondary wastes. Results of the effects of various leachants in removing Uranium and the complications of co-leaching minerals/organic matter that are important for maintaining soil integrity and structure shall be discussed. Candidate leachants must remove the Uranium level below 35pCi/g of soil and produce a secondary waste that is amenable to on-site treatment at reasonable cost.

6251 (DOE/AL/62350–60F) **Long-term surveillance plan for the Shiprock disposal site, Shiprock, New Mexico.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Dec 1993. 118p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE94004832. Source: OSTI; NTIS; INIS; GPO Dep.

The long-term surveillance plan (LTSP) for the Shiprock, New Mexico, Uranium Mill Tailings Remedial Action (UMTRA) Project disposal site describes the surveillance activities for the Shiprock disposal cell. The US Department of Energy (DOE) will carry out these activities to ensure that the disposal cell continues to function as designed. This final LTSP is being submitted to the US Nuclear Regulatory Commission (NRC) as a requirement for issuance of a general license for custody and long-term care for the disposal site. The general license requires that the disposal cell be cared for in accordance with the provisions of this LTSP. This Shiprock, New Mexico, LTSP documents whether the land and interests are owned by the US or an Indian tribe and describes in detail the long-term care program through the UMTRA Project Office.

6252 (DOE/AL/62350–68F-Rev.1) **Surface and subsurface cleanup protocol for radionuclides, Gunnison, Colorado, UMTRA project processing site: Final report: Revision 1.** Gonzales, D. Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Dec 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE94004834. Source: OSTI; NTIS; INIS; GPO Dep.

Surface and subsurface soil cleanup protocols for the Gunnison, Colorado, processing site are summarized as follows: In accordance with EPA-promulgated land cleanup standards, in situ Ra-226 is to be cleaned up based on bulk concentrations not exceeding 5 and 15 pCi/g in 15-cm surface and subsurface depth increments, averaged over 100m^2 grid blocks, where the parent Ra-226 concentrations are greater than, or in secular equilibrium with, the Th-230 parent. In locations where Th-230 has differentially migrated in subsoil relative to Ra-226, a Th-230 clean up protocol has been developed. The cleanup of other radionuclides or nonradiological hazards that pose a significant threat to the public and the environment will be determined and implemented in accordance with pathway analysis to assess impacts and the implications of ALARA specified in 40 CFR Part 192 relative to supplemental standards.

6253 (DOE/AL/62350–86D) **UMTRA water sampling and analysis plan, Green River, Utah.** Papusch, R. Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Dec 1993. 45p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE94004837. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this water sampling and analysis plan (WSAP) is to provide a basis for groundwater and surface water sampling at the Green River Uranium Mill Tailing Remedial Action (UMTRA) Project site. This WSAP identifies and justifies the sampling locations, analytical parameters, detection limits, and sampling frequency for the monitoring locations.

6254 (DOE/AL/62350–88F) **Economic impact study of the Uranium Mill Tailings Remedial Action Project in Colorado: Colorado state fiscal year 1993.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Dec 1993. 47p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE94004839. Source: OSTI; NTIS; INIS; GPO Dep.

The Colorado economic impact study summarizes employment and economic benefits to the state from activities associated with the Uranium Mill Tailings Remedial Action (UMTRA) Project during Colorado state fiscal year 1993 (July 1, 1992, through June 30, 1993). To capture employment benefits, a questionnaire was distributed to subcontractor employees at the active UMTRA Project sites of Grand Junction, Rifle, and Gunnison, Colorado. An estimated 52 percent of the employees working on the UMTRA Project responded to this information request. Economic data were requested from each site prime subcontractor, as well as from the Remedial Action Contractor. The most significant benefits associated with the UMTRA Project in Colorado are summarized.

6255 (DOE/EH–0338T) **Ecological risk assessment guidance for preparation of remedial investigation/feasibility study work plans.** Pentecost, E.D. (Argonne National Lab., IL (United States)); Vinikour, W.S. Chicago Univ., IL (United States); Argonne National Lab., IL (United States). Aug 1993. 217p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94000980. Source: OSTI; NTIS; INIS; GPO Dep.

Draft.

This guidance document (1) provides instructions on preparing the components of an ecological work plan to complement the overall site remedial assessment investigation/feasibility study (RI/FS) work plan and (2) directs the user on how to implement ecological tasks identified in the plan. Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfired Amendments and Reauthorization Act of 1986 (SARA), an RI/FS work plan win have to be developed as part of the site-remediation scoping the process. Specific guidance on the RI/FS process and the preparation of work plans has been developed by the US Environmental Protection Agency (EPA 1988a). This document provides guidance to US Department of Energy (DOE) staff and contractor personnel for incorporation of ecological information into environmental remediation planning and decision making at CERCLA sites. An overview analysis of early ecological risk assessment methods (i.e., in the 1980s) at Superfund sites was conducted by the EPA (1989a). That review provided a perspective of attention given to ecological issues in some of the first RI/FS studies. By itself, that reference is of somewhat limited value; it does, however, establish a basis for comparison of past practices in ecological risk with current, more refined methods.

6256 (DOE/EH–0340) **Example process hazard analysis of a Department of Energy water chlorination process.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). Office of Deputy Assistant Secretary for Safety and Quality Assurance. Sep 1993. 109p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94001560. Source: OSTI; NTIS; GPO Dep.

On February 24, 1992, the Occupational Safety and Health Administration (OSHA) released a revised version of Section 29 Code of Federal Regulations CFR Part 1910 that added Section 1910.119, entitled "Process Safety Management of Highly Hazardous Chemicals" (the PSM Rule). Because US Department of Energy (DOE) Orders 5480.4 and 5483.1A prescribe OSHA 29 CFR 1910 as a standard in DOE, the PSM Rule is mandatory in the DOE complex. A major element in the PSM Rule is the process hazard analysis (PrHA), which is required for all chemical processes covered by the PSM Rule. The PrHA element of the PSM Rule requires the selection and application of appropriate hazard analysis methods to systematically identify hazards and potential accident scenarios associated with processes involving highly hazardous chemicals (HHCs). The analysis in this report is an example PrHA performed to meet the requirements of the PSM Rule. The PrHA method used in this example is the hazard and operability (HAZOP) study, and the process studied is the new Hanford 300-Area Water Treatment Facility chlorination process, which is currently in the design stage. The HAZOP study was conducted on May 18–21, 1993, by a team from the Westinghouse Hanford Company (WHC), Battelle-Columbus, the DOE, and Pacific Northwest Laboratory (PNL). The chlorination process was chosen as the example process because it is common to many DOE sites, and because quantities of chlorine at those sites generally exceed the OSHA threshold quantities (TQs).

6257 (DOE/EIS–0198-Rev.1) **Programmatic environmental impact statement for the Uranium Mill Tailings Remedial Action Ground Water Project: Revision 1, Draft.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). 19 Oct 1993. 207p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. (DOE/AL/62350–0198-Rev.1). Order Number DE94003177. Source: OSTI; NTIS; INIS; GPO Dep.

Public concern regarding the potential human health and environmental effects from uranium mill tailings led Congress to pass the Uranium Mill Tailings Radiation Control Act (UMTRCA) (Public Law 95-604) in 1978. In the UMTRCA, Congress acknowledged the potentially harmful health effects associated with uranium mill tailings at 24 abandoned uranium mill processing sites needing remedial action. Pursuant to the UMTRCA, the US Environmental Protection Agency (EPA) developed standards, which include exposure limits from surface contamination and concentration limits for ground water, to protect the public and the environment from potential radiological and nonradiological hazards from the abandoned mill processing sites. The US Department of Energy (DOE) is responsible for performing remedial action to bring the surface and ground water contaminant levels at the abandoned mill processing sites into compliance with the EPA standards. The DOE is accomplishing this function through the Uranium Mill Tailings Remedial Action (UMTRA) Project. A major first step in the UMTRA Ground Water Project is the preparation of this Programmatic Environmental Impact Statement (PEIS). This document analyzes potential impacts of the alternatives, including the proposed action. These alternatives are programmatic in that they are plans for conducting the UMTRA Ground Water Project. The alternatives do not address site-specific ground water compliance. This PEIS is a planning document that will provide a framework for conducting the Ground Water Project; assess the potential programmatic and environmental impacts of conducting the UMTRA Ground Water Project; provide a method for determining the site-specific ground water compliance strategies; and provide data and information that can be used to prepare site-specific environmental impacts analyses documents more efficiently.

6258 (DOE/EM–0109P) **Office of Technology Development Program for Research, Development, Demonstration, Testing, and Evaluation: FY 1993 Program Summary.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). Oct 1993. 224p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94002591. Source: OSTI; NTIS; INIS; GPO Dep.

DOE has set a goal to clean up its complex and to bring all sites into compliance with applicable environmental regulations. This initiative is slated for completion by the year 2019. Four years ago there was no coordinated plan for identifying or cleaning these contaminated sites. Since 1989, DOE's Office of Environmental Restoration and Waste Management has invested time, money, and manpower to establish a wide range of programs to meet this immense challenge. DOE is responsible for waste management and clean up of more than 100 contaminated installations in 36 states and territories. This includes 3,700 sites: over 26,000 acres, with hazardous or radioactive contaminated surface or groundwater, soil, or structures; over 26,000 acres requiring remediation, with the number growing as new sites are defined; 500 surplus facilities awaiting decontamination and decommissioning and approximately 5,000 peripheral properties (residences, businesses) that have soil contaminated with uranium tailings.

6259 (DOE/EM–94003781) **Cost Estimating Handbook for Environmental Restoration.** USDOE Environmental Restoration and Waste Management Cost Assessment Team, Washington, DC (United States). [1993]. 219p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003781. Source: OSTI; NTIS; INIS; GPO Dep.

Environmental restoration (ER) projects have presented the DOE and cost estimators with a number of properties that are not comparable to the normal estimating climate within DOE. These properties include: An entirely new set of specialized expressions and terminology. A higher than normal exposure to cost and schedule risk, as compared to most other DOE projects, due to changing regulations, public involvement, resource shortages, and scope of work. A higher than normal percentage of indirect costs to the total estimated cost due primarily to record keeping, special training, liability, and indemnification. More than one estimate for a project, particularly in the assessment phase, in order to provide input into the evaluation of alternatives for the cleanup action. While some aspects of existing guidance for cost estimators will be applicable to environmental restoration projects, some components of the present guidelines will have to be modified to reflect the unique elements of these projects. The purpose of this Handbook is to assist cost estimators in the preparation of environmental restoration estimates for Environmental Restoration and Waste Management (EM) projects undertaken by DOE. The DOE has, in recent years, seen a significant increase in the number, size, and frequency of environmental restoration projects that must be costed by the various DOE offices. The coming years will show the EM program to be the largest non-weapons program undertaken by DOE. These projects create new and unique estimating requirements since historical cost and estimating precedents are meager at best. It is anticipated that this Handbook will enhance the quality of cost data within

DOE in several ways by providing: The basis for accurate, consistent, and traceable baselines. Sound methodologies, guidelines, and estimating formats. Sources of cost data/databases and estimating tools and techniques available at DOE cost professionals.

6260 (DOE/ER/60991–T3) **Physiologically anaerobic microorganisms of the deep subsurface: Final performance report, June 1, 1990–August 31, 1993.** Stevens, S.E. Jr.; Chung, K.T. Memphis State Univ., TN (United States). Dept. of Biology. Oct 1993. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-90ER60991. Order Number DE94004417. Source: OSTI; NTIS; INIS; GPO Dep.

Anaerobic bacteria were isolated from deep subsurface sediment samples taken at study sites in Idaho (INEL) and Washington (HR) by culturing on dilute and concentrated medium. Morphologically distinct colonies were purified, and their responses to 21 selected physiological tests were determined. Although the number of isolates was small (18 INEL, 27 HR) some general patterns could be determined. Most strains could utilize all the carbon sources, however the glycerol and melizitose utilization was positive for 50% or less of the HR isolates. Catalase activity (27.78% at INEL, 74.07% at HR) and tryptophan metabolism (11.12% at INEL, 40.74% at HR) were significantly different between the two study sites. MPN and viable counts indicate that sediments near the water table yield the greatest numbers of anaerobes. Deeper sediments also appear to be more selective with the greatest number of viable counts on low-nutrient mediums. Likewise, only strictly obligate anaerobes were found in the deepest sediment samples. Selective media indicated the presence of methanogens, acetogens, and sulfate reducers at only the HR site.

6261 (DOE/EW/50625–T2) **Environmental Hazards Assessment Program annual report, [June 1992–June 1993].** Medical Univ. of South Carolina, Charleston, SC (United States). Oct 1993. 212p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE94004511. Source: OSTI; NTIS; INIS; GPO Dep.

This report, the Environment Hazards Assessment Program (EHAP) Annual Report, is the second of three reports that document activities under the EHAP grant and details progress made during the first year of the grant. The first year was devoted to the development of a working program implementation plan. During the developmental process some key objectives were achieved such as developing a Doctor of Philosophy degree program in Environmental Studies at MUSC (Medical University of South Carolina) and conducting the first Crossroads of Humanity series Round Table Forum. The PIP (Program Implementation Program) details the objectives, management and budgetary basis for the overall management and control of the grant over the next four years, the yearly program plans provide the monthly and day-to-day programmatic and budgetary control by which the PIP was developed.

6262 (DOE/EW/50625–T4) **[Environmental Hazards Assessment Program annual report, June 1992–June 1993]: South Carolina ETV Socratic Dialog II.** Medical Univ. of South Carolina, Charleston, SC (United States). Jun 1993. 122p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE94004509. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains the script from a videotaped dialogue concerning a hypothetical hazardous waste/community health risk scenario presented as a Round Table Forum. Various issues are explored, ranging from the scientific and technical aspects of environmental studies and remedial action, to public information and community involvement, to the economic impact on local communities. The roles of the media, local government and federal and state agencies are examined as well as sources for funding. In an attempt to gauge audience response and reaction, evaluation cards were distributed, and the comments and recommendations are included here.

6263 (DOE/EW/50625–T11) **[Environmental Hazards Assessment Program annual report, June 1992–June 1993]: Survey of environmental management training coordinators: Risk assessment/risk management training needs.** Medical Univ. of South Carolina, Charleston, SC (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE94004502. Source: OSTI; NTIS; INIS; GPO Dep.

The Medical University of South Carolina (MUSC) is conducting a survey of Risk Assessment and Risk Management. They are developing information on the existing level of risk associated with training and the perceived need for this training by both federal and private organizations. The purpose of the questionnaire is to determine the available training and the perception of the Risk Management process in the DOE. Of particular interest is the requirement for Risk Assessment/Management training in organizations that will be involved in the Decontamination and Decommissioning of DOE Facilities. The survey questions and instructions are included.

6264 (DOE/FTR–94001286) **Travel to Russia for coordination meetings for the Cooperative Program in Surety Technologies: Foreign trip report, July 3–15, 1993.** Nokes, K.D.; Newman, P.E.; Croessmann, C.D. Sandia National Labs., Albuquerque, NM (United States). 12 Oct 1993. 200p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE94001286. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Sandia National Laboratories, in cooperation with Los Alamos National Laboratory and Lawrence Livermore National Laboratory, is developing a cooperative program for the exchange of unclassified, non-sensitive surety technologies with the All Russia Institute of Experimental Physics (VNIIEF), which is known as Arzamas-16, and the All Russia Institute of Technical Physics (VNIITF), which is known as Chelyabinsk-70. This collaborative effort is designed to advance surety technology in both the US and Russia. Three day meetings were held with representatives of Chelyabinsk-70 in Ekaterinburg and with representatives of Arzamas-16 in Moscow. The attendees agreed to begin the cooperative program with symposia to cover the state-of-the-art at each laboratory in three topical areas: (1) risk assessment and the response of engineered systems to abnormal environments, (2) accident resistant containers and transportation surety, and (3) hazardous materials identification, handling, and management. The major purpose of the symposia is to assess the Russian labs' capabilities in surety technology, identify work packages the US laboratories can support with funding, and start contracts moving through the purchasing process. If the initial symposia are successful and contracts are placed with the Russian institutes, follow-on meetings will be held in the first quarter of CY94.

6265 (DOE/ID–10253-FY93) **Environmental Restoration and Waste Management Site-Specific Plan for Fiscal Year 1993.** USDOE Idaho Field Office, Idaho Falls, ID (United States). Mar 1993. 301p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE93016684. Source: OSTI; NTIS; INIS; GPO Dep.

The Idaho National Engineering Laboratory (INEL) is a US Department of Energy (DOE) multiprogram laboratory whose primary mission has been to research nuclear technologies. Working with these technologies and conducting other types of research generates waste, including radioactive and/or hazardous wastes. While most of the waste treatment, storage, and disposal practices have been effective, some practices have led to the release of contaminants to the environment. As a result, DOE has developed (1) an Environmental Restoration (ER) Program to identify and, where necessary, cleanup releases from inactive waste sites and (2) a Waste Management (WM) Program to safely treat, store, and dispose of DOE wastes generated from current and future activities in an environmentally sound manner. This document describes the plans for FY 1993 for the INEL's ER and WM programs as managed by DOE's Idaho Field Office (DOE-ID).

6266 (DOE/RL–92-46) **Phase 1 and 2 feasibility study report for the 300-FF-1 Operable Unit.** USDOE Richland Operations Office, WA (United States). Nov 1993. 289p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94003905. Source: OSTI; NTIS; GPO Dep.

The 300-FF-1 Operable Unit (OU) feasibility study (FS) presented in this document completes the FS process only through

the first two study phases: Phase I, Remedial Alternatives Development, and Phase II, Remedial Alternatives Screening in accordance with CERCIA guidance for performing Remedial Investigations and Feasibility Studies (RI/FS) (EPA 1988a). This Phase I/II study provides a generalized view of workable remedial technologies as applied to the site contamination problems as a whole. Phase III, Detailed Analysis of Alternatives, will be performed at a later date to further evaluate screened alternatives based on the nine criteria in the CERCLA RI/FS guidance. The purpose of this Phase I/II FS is to develop and screen a range of alternatives for remediation of contamination present in the vadose zone of the 300-FF-1 OU. The scope of work for this Phase I/II FS includes five primary tasks: 1. Review existing documents and their associated data from relevant investigations and studies; 2. Establish remedial action objectives (RAO) and general response actions (GRA); 3. Identify applicable or relevant and appropriate requirements (ARARS) pertinent to all general response actions (including waste disposal); 4. Develop remedial alternatives (Phase I) applicable to the 300-FF-1 OU including identification and screening of technologies and process options, and assembly of remedial alternatives from representative technology types; 5. Screen alternatives (Phase II) developed in Phase I for implementability, effectiveness, and cost to identify those alternatives which warrant advancement to the detailed analysis phase (Phase III) of the FS.

6267 (DOE/RL–93-04) **100 area excavation treatability test plan.** USDOE Richland Operations Office, WA (United States). May 1993. 58p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004483. Source: OSTI; NTIS; INIS; GPO Dep.

This test plan documents the requirements for a treatability study on field radionuclide analysis and dust control techniques. These systems will be used during remedial actions involving excavation. The data from this treatability study will be used to support the feasibility study (FS) process. Development and screening of remedial alternatives for the 100 Area, using existing data, have been completed and are documented in the 100 Area Feasibility Study, Phases 1 and 2 (DOE-RL 1992a). Based on the results of the FS, the Treatability Study Program Plan (DOE-RL 1992b) identifies and prioritizes treatability studies for the 100 Area. The data from the treatability study program support future focused FS, interim remedial measures (IRM) selection, operable unit final remedy selection, remedial design, and remedial actions. Excavation is one of the high-priority, near-term, treatability study needs identified in the program plan (DOE-RL 1992b). Excavation of contaminated soils and buried solid wastes is included in several of the alternatives identified in the 100 Area FS. Although a common activity, excavation has only been used occasionally at the Hanford Site for waste removal applications.

6268 (DOE/RL–93-75) **Hanford Facility contingency plan.** Sutton, L.N.; Miskho, A.G.; Brunke, R.C. USDOE Richland Operations Office, WA (United States). Oct 1993. 62p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004821. Source: OSTI; NTIS; INIS; GPO Dep.

The Hanford Facility Contingency Plan, together with each TSD unit-specific contingency plan, meets the WAC 173-303 requirements for a contingency plan. This plan includes descriptions of responses to a nonradiological hazardous materials spill or release at Hanford Facility locations not covered by TSD unit-specific contingency plans or building emergency plans. This plan includes descriptions of responses for spills or releases as a result of transportation activities, movement of materials, packaging, and storage of hazardous materials.

6269 (DOE/RL–93-89) **Schedule optimization study implementation plan.** USDOE Richland Operations Office, WA (United States). Nov 1993. 50p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004488. Source: OSTI; NTIS; INIS; GPO Dep.

This Implementation Plan is intended to provide a basis for improvements in the conduct of the Environmental Restoration (ER) Program at Hanford. The Plan is based on the findings of the Schedule Optimization Study (SOS) team which was convened for two weeks in September 1992 at the request of the U.S. Department of Energy (DOE) Richland Operations Office (RL). The need for the study arose out of a schedule dispute regarding the submission of the 1100-EM-1 Operable Unit (OU) Remedial Investigation/ Feasibility Study (RI/FS) Work Plan. The SOS team was comprised of independent professionals from other federal agencies and the private sector experienced in environmental restoration within the federal system. The objective of the team was to examine reasons for the lengthy RI/FS process and recommend ways to expedite it. The SOS team issued their Final Report in December 1992. The report found the most serious impediments to cleanup relate to a series of management and policy issues which are within the control of the three parties managing and monitoring Hanford – the DOE, U.S. Environmental Protection Agency (EPA), and the State of Washington Department of Ecology (Ecology). The SOS Report identified the following eight cross-cutting issues as the root of major impediments to the Hanford Site cleanup. Each of these eight issues is quoted from the SOS Report followed by a brief, general description of the proposed approach being developed.

6270 (DOE/RL/01830–H15) **Federal environmental standards of potential importance to operations and activities at US Department of Energy sites: Draft.** Fowler, K.M.; Bilyard, G.R.; Davidson, S.A.; Jonas, R.J.; Joseph, J. Pacific Northwest Lab., Richland, WA (United States). Jun 1993. 286p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE93019843. Source: OSTI; NTIS; GPO Dep.

The US Department of Energy (DOE) is now engaged in a program of environmental restoration nationwide across its 45 sites. It is also bringing its facilities into compliance with environmental regulations, decontaminating and decommissioning unwanted facilities, and constructing new waste management facilities. One of the most difficult questions that DOE must face in successfully remediating its inactive waste sites, decontaminating and decommissioning its inactive facilities, and operating its waste management facilities is: "What criteria and standards should be met?" Acceptable standards or procedures for determining standards will assist DOE in its conduct of ongoing waste management and pending cleanup activities by helping to ensure that those activities are conducted in compliance with applicable laws and regulations and are accepted by the regulatory community and the public. This document reports on the second of three baseline activities that are being conducted as prerequisites to either the development of quantitative standards that could be used by DOE, or consistent procedures for developing such standards. The first and third baseline activities are also briefly discussed in conjunction with the second of the three activities.

6271 (EGG-WTD–10875) **Test plan for the Rapid Geophysical Surveyor.** Roybal, L.G. EG and G Idaho, Inc., Idaho Falls, ID (United States). Jun 1993. 39p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE94002846. Source: OSTI; NTIS; INIS; GPO Dep.

This document describes the test plant for demonstrating and testing a set of optically pumped cesium-based total field magnetometers using the Rapid Geophysical Surveyor platform. The proposed testing will be used to assess the function of these magnetometers as deployed on the Rapid Geophysical Surveyor and evaluate the practical utility of high resolution magnetic data for supporting waste retrieval efforts.

6272 (FEMP–2294) **Project processes integration: An evaluation of legal and DOE requirements on project activities.** Vanoss, R.L. (Jacobs Engineering Group, Inc., Pasadena, CA (United States)); Cossel, S.C.; Risenhoover, G.M. Westinghouse Environmental Management Co. of Ohio, Cincinnati, OH (United States). Fernald Environmental Management Project. 12 Oct 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-92OR21972. (CONF-931095–52: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94002554. Source: OSTI; NTIS; GPO Dep.

Environmental restoration of five Operable Units at the Fernald Environmental Management Project (FENT) includes compliance with the requirements of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Resource Conservation Recovery Act (RCRA), (National Environmental Policy Act) NEPA,

and DOE Orders (and other Federal and State laws, and regulations not relevant to this paper). Each of the regulatory drivers have differing procedural requirements for documenting the calculations, decisions, and actions involved in site cleanup. Integration of documentation and avoidance of duplication can save both time and money at Fernald. Such savings are being achieved by operable unit specific application of a number of Supporting Studies, revised procedures, and guidance documents. Also, each operable unit is seeking appropriate opportunities to produce single documents (usually those mandated by CERCLA, the primary regulatory driver) that simultaneously fulfill the important requirements of the other regulations and DOE orders. These opportunities are evaluated at all successive phases of decision making, remedial design, and remedial action.

6273 (FEMP–2310) **Streamlining the OU3 RI/FS process to accommodate decontamination and dismantlement at Fernald.** Hampshire, L.H. (Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States)); Dalga, D.G.; Clark, T.R.; Throckmorton, J.D.; Janke, R.J. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-92OR21972. (CONF-931095–59: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94003187. Source: OSTI; NTIS; GPO Dep.

The importance of a proper and complete assessment of data needs, relative to the characterization of a site, can never be understated. Not only will this assessment assure that the appropriate types, levels, and numbers of samples are taken, but as evidenced by the subject project, can lead to significant time and cost savings. The Fernald Environmental Management Project (FEMP), formerly known as the Feed Materials Production Center (FMPC), covers an area measuring 4.25 square kilometers (1,050 acres) and is located in a rural agricultural area about 28 kilometers (17 miles) northwest of downtown Cincinnati, Ohio. The site is near the villages of Fernald, New Haven, Ross, and Shandon, Ohio. After providing some general background information on the site, and the subject RI/FS, the remainder of this presentation will focus on how the sampling approach was changed to reflect a reassessment of data needs, and the resultant benefits of that change. Specifically, discussion will be provided relative to the initial approach proposed for characterizing the contamination at the site, the revised, improved sampling approach contained in the approved RI/FS Work Plan Addendum, and the benefits derived from this change in the sampling approach.

6274 (FEMP–2311) **Acceleration of the remediation process through interim action.** Clark, T.R. (Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States)); Throckmorton, J.D.; Hampshire, L.H.; Dalga, D.G.; Janke, R.J. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-92OR21972. (CONF-931095–60: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94003186. Source: OSTI; NTIS; INIS; GPO Dep.

During the Remedial Investigation and Feasibility Study (RI/FS) phase of a CERCLA cleanup, it is possible to implement interim actions at a site "to respond to an immediate site threat or take advantage of an opportunity to significantly reduce risk quickly." An interim action is a short term action that addresses threats to public health and safety and is generally followed by the RI/FS process to achieve complete long term protection of human health and the environment. Typically, an interim action is small in scope and can be implemented quickly to reduce risks, such as the addition of a security fence around a known or suspected hazard, or construction of a temporary cap to reduce run-on/run-off from a contaminant source. For more specialized situations, however, the possibility exists to apply the intent of the interim action guidance to a much larger project scope. The primary focus of this paper is the discussion of the interim action approach for streamlined remedial action and presentation of an example large-scale project utilizing this approach at the Fernald Environmental Management Project (FEMP).

6275 (LA-UR–93-3625) **Probabilistic risk assessment of disassembly procedures.** O'Brien, D.A.; Bement, T.R.; Letellier, B.C. Los Alamos National Lab., NM (United States). 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–37: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94002644. Source: OSTI; NTIS; GPO Dep.

The purpose of this report is to describe the use of Probabilistic Risk (Safety) Assessment (PRA or PSA) at a Department of Energy (DOE) facility. PRA is a methodology for (i) identifying combinations of events that, if they occur, lead to accidents (ii) estimating the frequency of occurrence of each combination of events and (iii) estimating the consequences of each accident. Specifically the study focused on evaluating the risks associated with dissembling a hazardous assembly. The PRA for the operation included a detailed evaluation only for those potential accident sequences which could lead to significant off-site consequences and affect public health. The overall purpose of this study was to investigate the feasibility of establishing a risk-consequence goal for DOE operations.

6276 (LA-UR–93-3642) **Life safety and seismic hazards: Selecting buildings for review and questions still to answer.** Keller, M.D. Los Alamos National Lab., NM (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9310102–36: 4. energy natural phenomena hazards mitigation conference, Atlanta, GA (United States), 19-22 Oct 1993). Order Number DE94002710. Source: OSTI; NTIS; GPO Dep.

Los Alamos National Laboratory (LANL) is situated on the eastern flank of the Jemez Mountains in which lies the Valles Caldera, a volcanic center that erupted 1.1 to 1.5 million years ago. Los Alamos is also situated within the western margin of the Rio Grande Rift system, where there is a possibility for seismic activity. Within the Los Alamos area are numerous faults, some within a kilometer or two of LANL structures, some even closer. Many of the permanent structures within Los Alamos were designed and constructed in accordance with applicable building codes in the 1950s. These codes have now been determined to be deficient with respect to both forcing functions of seismic events and structure design. LANL, in response to a letter from the University of California dated October 29, 1990, began the Seismic Hazards Investigation Program to determine the characteristics of a probable seismic event at Los Alamos and to determine the ability of the existing structures to withstand the forces generated by such an event. In the Seismic Hazards Investigation Program, paleoseismic methods are used to determine seismic characterization and a systematic method is needed to investigate existing structures, systems, and components for the ability to resist seismic forces. This paper presents the methodology for determining seismic characterizations and structure prioritization and analysis at LANL for the Seismic Hazards Investigation Program.

6277 (LA-UR–93-3666) **Risk management at Los Alamos National Laboratory.** Brooks, D.G. (Arizona State Univ., Tempe, AZ (United States)); Stack, D.W. Los Alamos National Lab., NM (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–40: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94002712. Source: OSTI; NTIS; GPO Dep.

Los Alamos National Laboratory has risk management programs at a number of administrative levels. Each line organization has responsibility for risk management for routine operations. The Facility Risk Management group (HS-3) is the Los Alamos organization with the primary responsibility for risk management including providing input and expertise to facilities and line managers in the management and documentation of ES&H hazards and risks associated with existing and new activities. One of the major contributions this group has made to laboratory risk management program is to develop and implement a hazard identification and classification methodology that is readily adaptable to continuously changing classification guidelines such as DOE-STD-1027. The increased emphasis on safety at Los Alamos has led to the

formation of additional safety oversight organization such as the Integration and Coordination Office (ICO), which is responsible for prioritization of risk management activities. In the fall of 1991, nearly 170 DOE inspectors spent 6 weeks analyzing the environmental, safety, and health activities at Los Alamos. The result of this audit was a list of over 1000 findings, each indicating some deficiency in current Laboratory operations relative to DOE and other government regulation. The audit team's findings were consolidated and "action plans" were developed to address the findings. This resulted in over 200 action plans with a total estimated cost of almost $1 billion. The Laboratory adopted a risk-based prioritization process to attempt to achieve as much risk reduction as possible with the available resources. This paper describes the risk based prioritization model that was developed.

6278 (NUREG–1272-Vol.7-No.2) **Office for Analysis and Evaluation of Operational Data: 1992 annual report: Nonreactors: Volume 7, No. 2.** Nuclear Regulatory Commission, Washington, DC (United States). Office for Analysis and Evaluation of Operational Data. Oct 1993. 141p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

The annual report of the US Nuclear Regulatory Commission's Office for Analysis and Evaluation of Operational Data (AEOD) is devoted to the activities performed during 1992. The report is published in two separate parts. NUREG-1272, Vol. 7, No. 1, covers power reactors and presents an overview of the operating experience of the nuclear power industry from the NRC perspective, including comments about the trends of some key performance measures. The report also includes the principal findings and issues identified in AEOD studies over the past year and summarizes information from such sources as licensee event reports, diagnostic evaluations, and reports to the NRC's Operations Center. NUREG-1272, Vol. 7, No. 2, covers nonreactors and presents a review of the events and concerns during 1992 associated with the use of licensed material in nonreactor applications, such as personnel overexposures and medical misadministrations. Both reports also contain a discussion of the Incident Investigation Team program and summarize both the Incident Investigation Team and Augmented Inspection Team reports. Each volume contains a list of the AEOD reports issued for 1981–1992.

6279 (ORNL/ER/Sub–87-99053/55) **Waste Management Plan for the Remedial Investigation of Waste Area Grouping 10, Operable Unit 3, at Oak Ridge National Laboratory, Oak Ridge, Tennessee: Environmental Restoration Program.** Bechtel National, Inc., Oak Ridge, TN (United States); Oak Ridge National Lab., TN (United States). Oct 1993. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94003516. Source: OSTI; NTIS; INIS; GPO Dep.

This Waste Management Plan (WMP) supplements the Remedial Investigation/Feasibility Study (RI/FS) Project WMP and defines the criteria and methods to be used for managing and characterizing waste generated during activities associated with the RI of 23 wells near the Old Hydrofracture Facility (OHF). These wells are within the Waste Area Grouping (WAG) 5 area of contamination (AOC) at Oak Ridge National Laboratory (ORNL). Field activities for the limited RI of Operable Unit (OU) 3 of WAG 10 will involve sampling and measurement of various environmental media (e.g., liquids and gases). Many of these activities will occur in areas known to be contaminated with radioactive materials or hazardous chemical substances, and it is anticipated that contaminated solid and liquid wastes and noncontaminated wastes will be generated as a result of these activities. On a project-wide basis, handling of these waste materials will be accomplished in accordance with the RI/FS Project WMP and the procedures referenced throughout the plan.

6280 (PNL–8981) **An evaluation of the adequacy of vital status follow-up in the Hanford worker mortality study.** Omohundro, E.L. (Hanford Environmental Health Foundation, Richland, WA (United States)); Gilbert, E.S. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 37p. Sponsored by USDOE, Washington, DC (United States);National Inst. for Occupational Safety and Health, Rockville, MD (United States). DOE Contract AC06-76RL01830. Order Number DE94005179. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the study described in this report was to evaluate the completeness of vital status ascertainment in the Hanford worker cohort. Identifying information on 17,708 Hanford workers, including all workers who were monitored for external radiation exposure, employed at least six months at the Hanford site, and whose vital status remains unknown, was submitted to a private search organization, Equifax Government and Special Systems. Equifax then linked Social Security numbers of these workers with death information files. For the period 1945–86 that has been emphasized in recent dose-response analyses of the Hanford data, Equifax ascertained only 12 new deaths, an increase of only 0.2% over deaths that had been ascertained previously. In addition, Equifax ascertained 23 deaths that were judged to be mismatches based on comparison of names and birth-dates on their files and ours; it is shown that this number can be regarded as a rough estimate of the number of deaths missed because workers had incorrect Social Security numbers. Overall the study suggests that the number of deaths missed was not large, but the confidence one can place in this conclusion is limited by the fact that Equifax's ascertainment procedures are not perfect, especially for the period before 1965. In order to evaluate the adequacy of the methods used by Equifax, information on 2,254 Hanford workers who had been previously identified as dead was also submitted. Equifax missed less than 2% of known Hanford deaths occurring in the period 1965–86, but missed about 18% of deaths occurring before 1965. Although recent analyses have focused on the period 1945–86, some analyses have included deaths ascertained using direct linkage with Washington state death files for the period 1987–89.

6281 (PNL-SA–22357) **MEPAS exposure model updates to meet current EPA guidance.** Strenge, D.L.; Droppo, J.G. Jr. Pacific Northwest Lab., Richland, WA (United States). [1993]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931095–67: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94003723. Source: OSTI; NTIS; GPO Dep.

The Multimedia Environmental Pollutant Assessment System (MEPAS) is a software package developed for the US Department of Energy (DOE) as a management tool to screen the many potential hazardous waste problems at DOE facilities across the country. The program considers both radioactive and chemical pollutants in estimating potential human health risks based on site-specific waste, environmental transport, and exposure characteristics. To support various DOE programs, recent modifications have been made to MEPAS to increase its applicability in analyzing the problems of mixed hazardous waste. Such analyses are needed to evaluate remediation options for mixed hazardous waste sites. This paper presents an overview of the MEPAS program and summarizes the current models used to translate environmental concentration values into projected intake by humans and, finally, into estimates of health risk. The recent modifications are described consistent with current EPA guidance for exposure and human health impact assessment.

6282 (PNL-SA–22393) **Applicability of slug interference testing of hydraulic characterization of contaminated aquifer sites.** Spane, F.A. (Pacific Northwest Lab., Richland, WA (United States)); Swanson, L.C. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931095–70: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94004299. Source: OSTI; NTIS; INIS; GPO Dep.

Aquifer test methods available for characterizing hazardous waste sites are sometimes restricted because of problems with disposal of contaminated groundwater. These problems, in part, have made slug tests a more desirable method of determining hydraulic properties at such sites. However, in higher permeability formations (i.e., transmissivities $\geq 1 \times 10^{-3}$ m^2/s), slug test results often cannot be analyzed and give, at best, only a lower limit for transmissivity. A need clearly exists to develop test methods that can be used to characterize higher permeability aquifers without removing large amounts of contaminated groundwater. One hydrologic test method that appears to hold promise for characterizing such sites

is the slug interference test. To assess the applicability of this test method for use in shallow alluvial aquifer systems, slug interference tests have been conducted, along with more traditional aquifer testing methods, at several Hanford multiple-well sites. Transmissivity values estimated from the slug interference tests were comparable (within a factor of 2 to 3) to values calculated using traditional testing methods, and made it possible to calculate the storativity or specific yield for the intervening test formation. The corroboration of test results indicates that slug interference testing is a viable hydraulic characterization method in transmissive alluvial aquifers, and may represent one of the few test methods that can be used in sensitive areas where groundwater is contaminated.

6283 (PNL-SA–23363) **Technology information profile: RL321103 – In situ gamma spectrometer.** Schilk, A.J. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004594. Source: OSTI; NTIS; INIS; GPO Dep.

Past operations of uranium production and support facilities at several Department of Energy (DOE) sites have occasionally resulted in the local contamination of some surface and subsurface soils. Such contamination commonly occurs within waste burial sites, cribs, pond bottom sediments, and areas surrounding waste tanks or uranium scrap, ore, tailing, and slag heaps. The thorough cleanup of these sites is a major public concern and a high priority for the DOE, but before any effective remedial protocols can be established, the three-dimensional distributions of the uranium contaminants must be adequately characterized. Unfortunately, traditional means of obtaining soil activities (e.g., grab sampling followed by laboratory analyses) are notoriously cumbersome, expensive, time-consuming, and often non-representative when very large areas are being surveyed. Hence, new technologies must be developed, or existing ones improved, to allow for the cheaper, better, faster (i.e., real-time) and safer characterization of uranium concentrations at these critical sites. The primary objective for this program is to develop, construct, and field/pilot test the in situ gamma spectrometer for the rapid measurement of uranium in surface and shallow subsurface soils at the Fernald site in Ohio.

6284 (RFP–4745) **MACCS usage at Rocky Flats Plant for consequence analysis of postulated accidents.** Foppe, T.L.; Peterson, V.L. EG and G Rocky Flats, Inc., Golden, CO (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC34-90DP62349. (CONF-940312–14: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94000994. Source: OSTI; NTIS; INIS; GPO Dep.

The MELCOR Accident Consequence Code System (MACCS) has been applied to the radiological consequence assessment of potential accidents from a non-reactor nuclear facility. MACCS has been used in a variety of applications to evaluate radiological dose and health effects to the public from postulated plutonium releases and from postulated criticalities. These applications were conducted to support deterministic and probabilistic accident analyses for safety analyses for safety analysis reports, radiological sabotage studies, and other regulatory requests.

6285 (RFP–4748) **Fire risk assessments at Rocky Flats Plant.** Foppe, T.L.; Stahlnecker, E. EG and G Rocky Flats, Inc., Golden, CO (United States). Rocky Flats Plant. [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC34-90DP62349. (CONF-940312–15: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94000993. Source: OSTI; NTIS; GPO Dep.

Short communication. ROCKY FLATS PLANT/risk assessment; FIRES/risk assessment; FIRES; SAFETY; PLUTONIUM; PRODUCTION; ACCIDENTS; HEALTH HAZARDS; SOURCE TERMS

6286 (SAND–93-1888) **Vugraph presentations of the fourth DOE Industry/University/Lab Forum on Robotics for Environmental Restoration and Waste Management.** Sandia National Labs., Albuquerque, NM (United States). Oct 1993. 170p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9307149–Vugraphs: 4. DOE Industry/University/Lab forum on robotics for environmental restoration and waste management, Albuquerque, NM (United States), 19-21 Jul 1993). Order Number DE94002610. Source: OSTI; NTIS; GPO Dep.

This document is a compilation of various presentations from the Fourth DOE Industry/University/Lab Forum on Robotics for Environmental Restoration and Waste Management held in Albuquerque, New Mexico July 19–21, 1993. Separate abstracts were prepared for each presentation of this report.

6287 (UCRL-ID–115208) **Nuclear criticality safety evaluation of Spray Booth Operations in X-705, Portsmouth Gaseous Diffusion Plant.** Sheaffer, M.K.; Keeton, S.C. Lawrence Livermore National Lab., CA (United States). 20 Sep 1993. 71p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004809. Source: OSTI; NTIS; INIS; GPO Dep.

This report evaluates nuclear criticality safety for Spray Booth Operations in the Decontamination and Recovery Facility, X-705, at the Portsmouth Gaseous Diffusion Plant. A general description of current procedures and related hardware/equipment is presented. Control parameters relevant to nuclear criticality safety are explained, and a consolidated listing of administrative controls and safety systems is developed. Based on compliance with DOE Orders and MMES practices, the overall operation is evaluated, and recommendations for enhanced safety are suggested.

6288 (UCRL-JC–115297) **Site characterization and hazard assessment criteria for natural phenomena hazards at DOE sites.** Chen, J.C.; Lu, S.C.; Ueng, T.S.; Boissonnade, A.C. Lawrence Livermore National Lab., CA (United States). Sep 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9310102–40: 4. energy natural phenomena hazards mitigation conference, Atlanta, GA (United States), 19-22 Oct 1993). Order Number DE94004020. Source: OSTI; NTIS; GPO Dep.

This paper briefly summarizes requirements for site characterization and hazard assessment of Natural Phenomena Hazards for compliance with DOE Order 5480.28. The site characterization criteria for NPH evaluation are provided in a draft DOE-STD-1022-XX and the assessment criteria of natural phenomena hazards are provided in draft DOE-STD-1023-XX.

6289 (UCRL-JC–115411) **Application of the DOE and NRC Nuclear Safety Policy to transportation operations.** Kimura, Chris Y. (Lawrence Livermore National Lab., CA (United States)); Sandquist, G.M. Lawrence Livermore National Lab., CA (United States). 10 Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940312–23: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001611. Source: OSTI; NTIS; INIS; GPO Dep.

The transportation of Department of Energy (DOE) materials and components throughout the United States and the world is a major, ubiquitous activity essential to the mission of DOE. Historically, DOE transportation activities have been performed without major impact upon the public; and in comparison with the safety record of other potentially hazardous materials, the DOE safety record has been excellent. Indeed, the risk to public health and safety from packaging, shipping and receiving DOE transported materials has been remarkably minimal. This report is a discussion of safety policies related to transportation operations.

6290 (WHC-EP–0468-2) **Facility effluent monitoring plan for the plutonium-uranium extraction facility.** Lohrasbi, J. (Westinghouse Hanford Co., Richland, WA (United States)); Johnson, D.L.; De Lorenzo, D.S. Westinghouse Hanford Co., Richland, WA (United States). Dec 1993. 249p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004845. Source: OSTI; NTIS; INIS; GPO Dep.

A facility effluent monitoring plan is required by the US Department of Energy in DOE Order 5400.1 for any operations that involve hazardous materials and radioactive substances that could impact employee or public safety or the environment. This document is prepared using the specific guidelines identified in A Guide

for Preparing Hanford Site Facility Effluent Monitoring Plans, WHC-EP-0438-01. This facility effluent monitoring plan assesses effluent monitoring systems and evaluates whether they are adequate to ensure the public health and safety as specified in applicable federal, state, and local requirements. This facility effluent monitoring plan shall ensure long-range integrity of the effluent monitoring systems by requiring an update whenever a new process or operation introduces new hazardous materials or significant radioactive materials. This document must be reviewed annually even if there are no operational changes, and it must be updated at a minimum of every three years.

6291 (WHC-EP–0672) **Radioactive waste shipments to Hanford Retrievable Storage from the General Electric Vallecitos Nuclear Center, Pleasanton, California.** Vejvoda, E.J. (Los Alamos Technical Associates, Inc., NM (United States)); Pottmeyer, J.A.; DeLorenzo, D.S.; Weyns-Rollosson, M.I.; Duncan, D.R. Westinghouse Hanford Co., Richland, WA (United States). Oct 1993. 298p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94003467. Source: OSTI; NTIS; INIS; GPO Dep.

During the next two decades the transuranic (TRU) wastes now stored in the burial trenches and storage facilities at the Hanford Site are to be retrieved, processed at the Waste Receiving and Processing Facility, and shipped to the Waste Isolation Pilot Plant near Carlsbad, New Mexico for final disposal. Approximately 3.8% of the TRU waste to be retrieved for shipment to WIPP was generated at the General Electric (GE) Vallecitos Nuclear Center (VNC) in Pleasanton, California and shipped to the Hanford Site for storage. The purpose of this report is to characterize these radioactive solid wastes using process knowledge, existing records, and oral history interviews. The waste was generated almost exclusively from the activities, of the Plutonium Fuels Development Laboratory and the Plutonium Analytical Laboratory. Section 2.0 provides further details of the VNC physical plant, facility operations, facility history, and current status. The solid radioactive wastes were associated with two US Atomic Energy Commission/US Department of Energy reactor programs – the Fast Ceramic Reactor (FCR) program, and the Fast Flux Test Reactor (FFTR) program. These programs involved the fabrication and testing of fuel assemblies that utilized plutonium in an oxide form. The types and estimated quantities of waste resulting from these programs are discussed in detail in Section 3.0. A detailed discussion of the packaging and handling procedures used for the VNC radioactive wastes shipped to the Hanford Site is provided in Section 4.0. Section 5.0 provides an in-depth look at this waste including the following: weight and volume of the waste, container types and numbers, physical description of the waste, radiological components, hazardous constituents, and current storage/disposal locations.

6292 (WHC-MR–0400) **Engineering assessment of low-level liquid waste disposal caisson locations at the 618-11 Burial Grounds.** Phillips, S.J. (Westinghouse Hanford Co., Richland, WA (United States)); Fischer, D.D.; Crawford, R.C.; Rising, J.L. Westinghouse Hanford Co., Richland, WA (United States). Jun 1982. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004495. Source: OSTI; NTIS; GPO Dep.

Rockwell Hanford Operations is currently involved in an extensive effort to perform interim ground surface stabilization activities at retired low-level waste burial grounds located at the Hanford Site, Richland, Washington. The principal objective of these activities is to promote increased occupational and radiological safety at burial grounds. Interim stabilization activities include: (1) load testing (traversing burial ground surfaces with heavy equipment to promote incipient collapse of void spaces within the disposal structure and overburden), (2) barrier placement (placement of a $\geq$ 0.6 m soil barrier over existing overburden), and (3) revegetation (establishment of shallow rooted vegetation on the barrier to mitigate deep rooted plant growth and to reduce erosion). Low-level waste disposal caissons were used in 300 Area Burial Grounds as internment structures for containerized liquid wastes. These caissons, by virtue of their contents, design and methods of closure, require long-term performance evaluation. As an initial activity to evaluate long-term performance, the accurate location of these structures is required. This topical report summarizes engineering activities used to locate caissons in the subsurface environment at the Burial Ground. Activities were conducted to locate caissons during surface stabilization activities. The surface locations were marked, photographed, and recorded on an as built engineering drawing. The recorded location of these caissons will augment long-term observations of confinement structure and engineered surface barrier performance. In addition, accurate caisson location will minimize occupational risk during monitoring and observation activities periodically conducted at the burial ground.

6293 (WHC-SA–1946) **Projecting the range of potential future climate change as an aid in the assessment of the effectiveness of the Hanford Site Permanent Isolation Barrier.** Petersen, K.L. Westinghouse Hanford Co., Richland, WA (United States). Oct 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-9310135–2: 32. Hanford symposium on health and the environment, Richland, WA (United States), 18-21 Oct 1993). Order Number DE94003093. Source: OSTI; NTIS; INIS; GPO Dep.

The Hanford Site Permanent Isolation Barrier Development Program was organized to develop an in-place disposal capability for low-level nuclear waste for the US Department of Energy at the Hanford Site in south-eastern Washington. Layered earthen and engineered barriers are being developed by Westinghouse Hanford Company and the Pacific Northwest Laboratory that will function in what is presently a semiarid environment (annual precipitation 150 mm) for at least 1,000 yr by limiting the infiltration of water through the waste. The Long-Term Climate Change Task is one of several key barrier tasks. Based on the recommendation of a panel of internationally recognized climate and modeling experts, climatic data for this task is being acquired in a step-wise and multidisciplinary manner. The specific research strategy includes literature review and specialized studies to obtain pollen-derived climatic reconstruction, documented historic weather patterns, and Global Circulation Model output of potential future climate changes related to both the greenhouse effect and the cycling into the next ice age. The specific goals of the task are to: (1) obtain defensible probabilistic projections of the long-term climate variability in the Hanford Site region at many different time scales into the future, (2) develop several test case climate scenarios that bracket the range of potential future climate, and (3) use the climate scenarios both to test and to model protective barrier performance.

6294 (WHC-SA–2163) **The evolution of Hanford Environmental Restoration program planning, estimating and baselining.** Jordan, K.N.; Lind, C.R.; Gerth, R.B. Westinghouse Hanford Co., Richland, WA (United States). Oct 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-9310186–3: Environmental restoration on laser options, Atlanta, GA (United States), 24-28 Oct 1993). Order Number DE94003503. Source: OSTI; NTIS; GPO Dep.

Environmental Restoration (ER) planning, cost estimating and baselining efforts represent a unique challenge even to the experienced planner, estimator or program manager. ER work at US Department of Energy (DOE) installations if not typical of the large construction projects or the production programs of the past. This paper will discuss the evolution of the Hanford Site ER Program efforts in dealing with these challenges, with a focus on lessons learned. The intent is to share Hanford planning experience with other ER participants through out the DOE installations.

6295 (WHC-SA–2189) **Confined space entry program for the Westinghouse Hanford Company.** Cornell, T.M. Westinghouse Hanford Co., Richland, WA (United States). Nov 1993. 72p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-9311133–1: Advanced industrial hygiene and safety seminar, New Orleans, LA (United States), 9-11 Nov 1993). Order Number DE94003491. Source: OSTI; NTIS; INIS; GPO Dep.

To comply with anticipated OSHA regulatory requirements concerning Permit-Required Confined Spaces, Westinghouse Hanford Company (WHC) created a Confined Spaces Task Team. The primary focus of the task team was to prepare a formal Confined Space Entry (CSE) Program that would ensure full compliance with the anticipated OSHA requirements. A comprehensive training plan

was also prepared and submitted for approval as soon as the new CSE Program was approved and released for implementation. On January 14, 1993, OSHA released their final ruling which contained several further changes, requiring the WHC Confined Space Entry Program and Training Plan to be revised. The revised training manual and lessons learned in establishing a Confined Space Entry Program are presented.

6296 (WHC-SD-EN-SPP–003) **Soil washwater treatment system operating procedure.** Green, J.W. Westinghouse Hanford Co., Richland, WA (United States). 2 Nov 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004410. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes the Met-Pro Physical Chemical Treatment System which incorporates numerous integrated processes either physical or chemical in nature. They include the following: coagulation with chemicals; rapid mixing to assure intimate contact of influent and coagulant; controlled flocculation for maximum flock growth via addition of polymer; extended time clarification for optimum settling of solids; solids collection and disposal, and recycle for seeding; filtration for additional suspended solids removal; and ion exchange removal of uranium and heavy metals.

6297 (WHC-SD-WM-FRD–011) **Functions and requirements for subsurface barriers used in support of single-shell tank waste retrieval.** Lowe, S.S. Westinghouse Hanford Co., Richland, WA (United States). 16 Nov 1993. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004257. Source: OSTI; NTIS; INIS; GPO Dep.

The mission of the Tank Waste Remediation System (TWRS) Program is to store, treat, and immobilize highly radioactive Hanford waste in an environmentally sound, safe, and cost-effective manner. The scope of the TWRS Program includes project and program activities for receiving, storing, maintaining, treating, and disposing onsite, or packaging for offsite disposal, all Hanford tank waste. Hanford tank waste includes the contents of 149 single-shell tanks (SSTs) and 28 double-shell tanks (DSTs), plus any new waste added to these facilities, and all encapsulated cesium and strontium stored onsite and returned from offsite users. A key element of the TWRS Program is retrieval of the waste in the SSTs. The waste stored in these underground tanks must be removed in order to minimize environmental, safety, and health risks associated with continuing waste storage. Subsurface barriers are being considered as a means to mitigate the effects of tank leaks including those occurring during SST waste retrieval. The functions to be performed by subsurface barriers based on their role in retrieving waste from the SSTs are described, and the requirements which constrain their application are identified. These functions and requirements together define the functional baseline for subsurface barriers.

6298 (WSRC-MS–93-245) **Human error model adaptation and validation for Savannah River Site nonreactor facilities.** Eide, S.A. (Los Alamos Technical Associates, Inc., Idaho Falls, ID (United States)); Benhardt, H.C.; Held, J.E.; Olsen, L.M.; Vail, R.E. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940312–6: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE93040722. Source: OSTI; NTIS; GPO Dep.

As part of an overall effort to improve safety analysis methods for the Savannah River Site (SRS) nonreactor nuclear facilities, a comprehensive human reliability analysis (HRA) methodology has been developed and selectively validated. The HRA methodology covers a wide variety of human errors that may exist in risk analyses of the nonreactor nuclear facilities. Such risk analyses are an integral part of safety analysis reports (SARS) at the SRS, forming the basis for severe accident analysis and assisting in the identification of safety classes for equipment. Nonreactor nuclear facilities at the SRS include nuclear fuel fabrication and reprocessing, nuclear waste processing, and nuclear waste storage and disposal. The SRS HRA methodology improvement included both adaptation of existing human error models and validation of selected model results with SRS-specific data on actual human errors. The data were obtained from three existing SRS data bases: (1) Fuel Processing, (2) Fuel Fabrication, and (3) Waste Management. These three are part of the Risk Analysis Methodology (RAM) Fault Tree data banks. Events in these data banks are obtained from a wide variety of sources, including operator log books, occurrence reports, safety newsletters, and others. Validation of the human error models involved comparison with SRS-specific data and calibration of model results where appropriate.

6299 (WSRC-RP–92-984) **Assessment of strontium in the Savannah River Site environment.** Carlton, W.H.; Evans, A.G.; Geary, L.A.; Murphy, C.E. Jr.; Strom, R.N. Westinghouse Savannah River Co., Aiken, SC (United States). [1992]. 81p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94005139. Source: OSTI; NTIS; INIS; GPO Dep.

This document on strontium is published as a part of the Radiological Assessment Program (RAP). It is the sixth in a series of eight documents on individual radioisotopes released to the environment as a result of SRS (Savannah River Site) operations. Strontium exists in the environment as a result of above-ground nuclear weapons tests, the Chernobyl accident, the destruction of satellite Cosmos 954, small releases from reactors and reprocessing plants, and the operation of industrial, medical, and educational facilities. Strontium has been produced at SRS during the operation of 5 production reactors. About 300 curies of radiostrontium were released into streams in the late 50s and 60s, primarily from leaking fuel elements in reactor storage basins. Smaller quantities were released from the fuel reprocessing operations. About 400 Ci were released to seepage basins. A much smaller quantity, about 2 Ci, was released to the atmosphere. The overall radiological impact of SRS releases on the offsite maximum individual can be characterized by total doses of 6.2 mrem (atmospheric) and 1.4 mrem (liquid), compared with a dose of 12,960 mrem from non-SRS sources during the same period of time. Radiostrontium releases have resulted in a negligible risk to the environment and the population it supports.

6300 (WSRC-RP–93-890) **US EPA record of decision review for landfills: Sanitary landfill (740-G), Savannah River Site.** Westinghouse Savannah River Co., Aiken, SC (United States). Jun 1993. 83p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94003907. Source: OSTI; NTIS; INIS; GPO Dep.

This report presents the results of a review of the US Environmental Protection Agency (EPA) Record of Decision System (RODS) database search conducted to identify Superfund landfill sites where a Record of Decision (ROD) has been prepared by EPA, the States or the US Army Corps of Engineers describing the selected remedy at the site. ROD abstracts from the database were reviewed to identify site information including site type, contaminants of concern, components of the selected remedy, and cleanup goals. Only RODs from landfill sites were evaluated so that the results of the analysis can be used to support the remedy selection process for the Sanitary Landfill at the Savannah River Site (SRS).

6301 (WSRC-TR–93-347-Rev.1) **SRS ES and H Standards Compliance Program Implementation Plan: Revision 1.** Hearn, W.H. Westinghouse Savannah River Co., Aiken, SC (United States). 8 Sep 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004440. Source: OSTI; NTIS; INIS; GPO Dep.

On March 8, 1990, the Defense Nuclear Facilities Safety Board (DNFSB) issued Recommendation 90-2 to the Secretary of Energy. This recommendation, based upon the DNFSB's initial review and evaluation of the content and implementation of standards relating to the design, construction, operations, and decommissioning of defense nuclear facilities of the U.S. Department of Energy (DOE), called for three actions: identification of specific standards that apply to design, construction, operation and decommissioning of DOE facilities; assessment of the adequacy of those standards for protecting public health and safety; and determination of the extent to which they have and are being implemented. The purpose of this Implementation Plan is to define the single program for all sitewide and facility 90-2 ES and H Standards Compliance efforts, which

will satisfy the HQ Implementation Plan, avoid duplicate efforts, be as simple and achievable as possible, include cost-saving innovations, use a graded approach based on facility hazards and future needs of facilities, and support configuration control for facility requirements. The Defense Waste Processing Facility (DWPF) has been designated a pilot facility for the 90-2 program and has progressed with their facility program ahead of the site-level program. The DWPF, and other Government-Owned Contractor-Operated (GOCO) facilities that progress on an enhanced schedule, will serve as pilot facilities for the site-level program. The lessons learned with their requirement identifications, and their assessments of the adequacy of and their compliance with these requirements will be used to improve the efficiency of the site-level and subsequent programs.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 6168, 6169, 6924, 6926, 7322, 7955

6302 (DOE/FTR–93017127) **Technical discussions with the Russian Federation concerning the AT400R fissile material container: Foreign trip report, June 3–20, 1993.** Freedman, J.M.; Glass, R.E.; Pacheco, R.S. Sandia National Labs., Albuquerque, NM (United States). 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93017127. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This was a container meeting. The principal purpose was to reach agreement with the Russia Federation Representatives on the requirements for the design of the AT-400R Container.

6303 (DOE/IG–0337) **The use of intelligence information to identify the foreign interests of entities involved with DOE programs.** USDOE Office of Inspector General, Washington, DC (United States). Office of Inspections. 22 Oct 1993. 44p. Sponsored by USDOE, Washington, DC (United States). Source: OSTI (Free of Charge).

Report to The Secretary.

This report investigates whether DOE activities could benefit from greater and more consistent access to intelligence information on selected entities with foreign interests. It does not cover dual-use and munition commodities. The investigation determined what information was available from the national intelligence community and law enforcement agencies that would have prevented DOE contracts with selected entities if the information had been available and regulations regarding contracts with selected entities had been enforced.

6304 (DOE/RL–93-90) **Security Transition Program Office 1994 fiscal year work plan WBS 6.11.** Brogdon, R.C. Jr. USDOE Richland Operations Office, WA (United States). Oct 1993. 103p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004896. Source: OSTI; NTIS; INIS; GPO Dep.

The Security Transition Program Office (STPO) will change the Hanford Safeguards and Security Protection Program from one that supported the national defense program to one that supports environmental restoration and waste management. A Successful Safeguards and Security Protection Program transition will have an industrial security foundation supplemented to protect material interests and information resources. The transition will change the current approaches to protection philosophy to ones that will provide the Hanford Site with the following: consolidation, reduction, and elimination of safeguards and security interests and targets; greater open Site access; maximum application of technology and automation; interpretation of security policies and procedures in light of the Hanford Site's environmental mission; coexistence with other emergency services; streamlined operations; and protection of employees and the public from health, safety, fire, security, and safeguards risks. This report describes the 1994 program objectives, the technical base, schedule baseline, cost, funding, manpower, and the 1993 program workscope.

6305 (IAEA-INFCIRC–419) **Report by the Director General of the International Atomic Energy Agency on behalf of the Board of Governors to all members of the Agency on the Non-Compliance of the Democratic People's Republic of Korea with the agreement between the IAEA and the Democratic People's Republic of Korea for the application of safeguards in connection with the treaty on the non-proliferation of nuclear weapons (INFCIRC/403) and on the Agency's inability to verify the non-diversion of material required to be sa** International Atomic Energy Agency, Vienna (Austria). 8 Apr 1993. 393p. (In Arabic, Chinese, English, Spanish, French, Order Number DE94611055. Source: OSTI; NTIS (US Sales Only); INIS.

The document contains the following items: Report by the Director General of the International Atomic Energy Agency on behalf of the Board of Governors to all members of the Agency on the non-compliance of the Democratic People's Republic of Korea with the agreement between the IAEA and the Democratic People's Republic of Korea for the application of Safeguards in connection with the treaty on the non-proliferation of nuclear weapons and on the Agency's inability to verify the non-diversion of material required to be safeguarded; resolution adopted by the Board on 1 April 1993 (Annex 1); Agreement of 30 January 1992 between the Government of the Democratic People's Republic of Korea and the International Atomic Energy Agency for the application of safeguards connection with the treaty on the non-proliferation of nuclear weapons (Annex 2); resolution adopted by the Board of Governors on 25 February 1993 (Annex 3); Communications from the Director General of the IAEA to the Minister for Atomic Energy of DPRK or from the Minister for Atomic Energy of the DPRK of the Director General of the IAEA (Annexes 3, 4, 5, 6, 8, 9, 11, 12); statement of the Government of the Democratic People's Republic of Korea, Pyongyang, 12 March 1993 (Annex 7); resolution adopted by the Board on 18 March 1993 (Annex 10).

6306 (LA-UR–93-2783) **Continuous remote/unattended monitoring for safeguards data collection systems.** Klosterbuer, S.F.; Halbig, J.K.; Harker, W.C.; Menlove, H.O.; Painter, J.A.; Stewart, J.E. Los Alamos National Lab., NM (United States). [1993]. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940307–1: International symposium on nuclear material safeguards, Vienna (Austria), 14-18 Mar 1994). Order Number DE93040265. Source: OSTI; NTIS; INIS; GPO Dep.

Short communication NUCLEAR FACILITIES/radiation monitoring; IAEA/safeguards; DATA ACQUISITION; RADIATION DETECTORS; DATA PROCESSING; ARMS CONTROL; PROLIFERATION; IAEA; SAFEGUARDS

6307 (LA-UR–93-2784) **Advances in gamma-ray field instrumentation at Los Alamos.** Halbig, J.K. (Los Alamos National Lab., NM (United States)); Klosterbuer, S.F.; Russo, P.A.; Sprinkle, J.K. Jr.; Smith, S.E. Los Alamos National Lab., NM (United States). [1993]. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940307–2: International symposium on nuclear material safeguards, Vienna (Austria), 14-18 Mar 1994). Order Number DE93040264. Source: OSTI; NTIS; INIS; GPO Dep.

Short communication. SAFEGUARDS; RADIATION DETECTORS/design; SELF-POWERED GAMMA DETECTORS/design; LANL; SAFEGUARDS; ARMS CONTROL; ELECTRONIC EQUIPMENT; DESIGN; PROLIFERATION

6308 (LA-UR–93-2848) **Comparison of three gamma-ray isotopic determination codes: FRAM, MGA, and TRIFID.** Cremers, T.L.; Malcolm, J.E.; Bonner, C.A. Los Alamos National Lab., NM (United States). [1993] 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940307–7: International symposium on nuclear material safeguards, Vienna (Austria), 14-18 Mar 1994). Order Number DE94000813. Source: OSTI; NTIS; INIS; GPO Dep.

Extended abstract.

Short communication. ISOTOPE RATIO/f codes; ISOTOPE RATIO/m codes; ISOTOPE RATIO/t codes; RADIOASSAY; COMPARATIVE EVALUATIONS; COINCIDENCE METHODS; PLUTONIUM 240; CALORIMETRY

6309 (LA-UR–93-2860) **Improved implementations of two gamma-ray measurement methods.** Parker, J.L.; Sampson, T.E. Los Alamos National Lab., NM (United States). [1993]. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940307–5: International symposium on

nuclear material safeguards, Vienna (Austria), 14-18 Mar 1994). Order Number DE93040254. Source: OSTI; NTIS; GPO Dep.

Short communication. PLUTONIUM/gamma detection; URANIUM/gamma detection; SAFEGUARDS; RADIOASSAY; PLUTONIUM; URANIUM; ENRICHED URANIUM; PLUTONIUM 240; URANIUM 238; URANIUM 235; ISOTOPE RATIO; NUCLEAR MATERIALS MANAGEMENT

6310 (LA-UR–93-2861) **Applications of portable gamma-ray technologies to quantitative measurements in-situ.** Bjork, C.W. (Los Alamos National Lab., NM (United States)); Russo, P.A.; Sheppard, G.A.; Smith, H.A.; Sprinkle, J.K. Jr.; Smith, S.E. Los Alamos National Lab., NM (United States). [1993]. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940307–6: International symposium on nuclear material safeguards, Vienna (Austria), 14-18 Mar 1994). Order Number DE93040253. Source: OSTI; NTIS; GPO Dep.

Generalized-geometry models and methodologies for calibration and assay of nuclear material holdup in process equipment are described. Four important keys to success in satisfying portable measurement needs for inventory of nuclear materials are: improvements in compact, single, rugged, reliable instrumentation for gamma-ray spectroscopy; real-time automation; design and automation of generalized models and methods to satisfy multiple measurements needs; and real-time automation of data acquisition/analysis.

6311 (LA-UR–93-2862) **Safeguards applications of pattern recognition and neural networks.** Howell, J.A.; Eccleston, G.W.; Whiteson, R.; Menlove, H.O.; Fuyat, C.C.; Halbig, J.K.; Klosterbuer, S.F.; Mullen, M.F. Los Alamos National Lab., NM (United States). [1993]. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940307–4: International symposium on nuclear material safeguards, Vienna (Austria), 14-18 Mar 1994). Order Number DE93040252. Source: OSTI; NTIS; GPO Dep.

Short communication. SAFEGUARDS/information systems; NEURAL NETWORKS/computer codes; PATTERN RECOGNITION/computer codes; SAFEGUARDS; DATA COMPILATION; REACTOR FUELING; NUCLEAR MATERIALS MANAGEMENT; TRANSPORT

6312 (LA-UR–93-3423) **An unavailability model for errors made during surveillance testing.** Bott, T.F. Los Alamos National Lab., NM (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–13: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94000816. Source: OSTI; NTIS; GPO Dep.

Periodic testing or examination is conducted routinely for some critical standby equipment or instrumentation, in an attempt to increase its availability. This is often called "surveillance testing." There is a finite probability that tested equipment will be left in a degraded or nonfunctioning state because of an error, and this important type of human error is often called a "restoration error" in probabilistic safety analysis (PSA) parlance. One would expect a trade-off between the reduction in unavailability gained by a surveillance testing and the increase in unavailability incurred by surveillance testing errors. In this paper, a mathematical model of the effect of errors made during surveillance testing on equipment unavailability is described.

6313 (UCRL-ID–106454-93-4) **Lawrence Livermore National Laboratory safeguards and security quarterly progress report to the US Department of Energy: Quarter ending September 30, 1993.** Ruhter, W.D.; Strait, R.S.; Mansur, D.L.; Davis, G. Lawrence Livermore National Lab., CA (United States). Oct 1993. 51p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004337. Source: OSTI; NTIS; GPO Dep.

The Lawrence Livermore National Laboratory (LLNL) carries out safeguards and security activities for the Department of Energy (DOE), Office of Safeguards and Security (OSS), as well as other organizations, both within and outside the DOE. This document summarizes the activities conducted for the OSS during the fourth quarter of Fiscal Year 1993 (July through September, 1993). The nature and scope of the activities carried out for OSS at LLNL require a broad base of technical expertise. To assure projects are staffed and executed effectively, projects are conducted by the organization at LLNL best able to supply the needed technical expertise. These projects are developed and managed by senior program managers. Institutional oversight and coordination is provided through the LLNL Deputy Director's office. At present, the Laboratory is supporting OSS in five areas: Safeguards Technology, Safeguard System Studies, Computer Security, DOE Automated Physical Security and DOE Automated Visitor Access Control System. The remainder of this report describes the activities in each of these five areas. The information provided includes an introduction which briefly describes the activity, summary of major accomplishments, task descriptions with quarterly progress, summaries of milestones and deliverables and publications published this quarter.

0560 Legislation and Regulations

Refer also to citation(s) 6295, 6639

6314 (IAEA-INFCIRC–209(rev.1/mod.1/add.2)) **Communications received from members regarding the export of nuclear material and of certain categories of equipment and other material.** International Atomic Energy Agency, Vienna (Austria). May 1993. 12p. (In Arabic, Chinese, English, Spanish, French, Order Number DE94611049. Source: OSTI; NTIS (US Sales Only); INIS.

The document reproduces the letter dated 11 February 1993 from the Resident Representative of the Russian Federation to the Agency concerning the export of nuclear material and of certain categories of equipment and other material.

6315 (INIS-XN–468) **SOR/92-150, 27 February 1992, Transport Packaging of Radioactive Materials, amendment.** Canada. 11 Mar 1992. 2p. (In English, French). Order Number DE94609510. Source: OSTI; NTIS (US Sales Only); INIS.

Published in the Canada Gazette Part II, Vol 126, No 6.

The amendments to the AECB Transport Packaging of Radioactive Materials Regulations have been made with a view to simplifying the registration procedure for obtaining such a certificate or approval under the above Transport Regulations. In effect there will no longer be a need for a separate fee system for registered users of certified package designs. (NEA).

6316 (INIS-XN–469) **1992 No 2997 The Public Information for Radiation Emergencies Regulations 1992.** United Kingdom. 26 Nov 1992. 6p. Order Number DE94609505. Source: OSTI; NTIS (US Sales Only); INIS.

These Regulations give effect in the United Kingdom to the Council of the European Communities Directive 89/618/Euratom on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency. They entered into force on 1 January 1993. (NEA).

6317 (INIS-XN–475) **Rules on radiation protection in the use and handling of unsealed radioactive sources.** Norway. 1 Jul 1981. 15p. (In Norwegian). Order Number DE94611051. Source: OSTI; NTIS; INIS.

These rules issued by the State Institute of Radiation Hygiene (SIS) concern the procedures for radiation protection when using/handling unsealed radioactive sources. They cover approvals, organization of work, competence, monitoring, controls, etc. (NEA).

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

6318 (KAERI/TR–269/92) **Optimization of heavy water production processes.** Chung, H. S. (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)). Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). May 1992. 72p. (In Korean). Order Number DE94610681. Source: OSTI; NTIS (US Sales Only); INIS.

Heavy water is used as moderator and coolant in Pressurized Heavy Water Power Plants. According to the governmental long-term plan for power supply, Korea is scheduled to construct new six pressurized heavy water power plants till the year 2006. Total heavy water demand for these plants would be 3892 Mg during the period 1992-2006. Reformed hydrogen processes which are considered best suited to Korea are optimized. (Author).

6319 (ORNL/FTR–4740) **Travel to Switzerland and France to review the operating history and identify its benefits at the Advanced Neutron Source Heavy Water Upgrade and Detritiation Facility: Foreign trip report, August 21–27, 1993.** DeVore, J.R.; Spagnolo, D.A. Oak Ridge National Lab., TN (United States). 27 Sep 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94000753. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Detritiation of heavy water is a new technology which has only a limited experience base at the commercial level. Light water reactors do not produce significant quantities of tritium and therefore the use of a detritiation facility in association with their operation is not required. However in heavy water reactors such as the ANS, tritium production is considerably higher, and detritiation of the heavy water is desirable in order to reduce doses to operating and maintenance personnel. There are several detritiation facilities which have been constructed around the world. Canada, France, Russia and India all now have completed or at least have started construction of facilities for detritiation. However, there are only two operating detritiation facilities: the Darlington Tritium Removal Facility (DTRF) located at the Darlington Nuclear Generating Station, and the Institute for Laue-Langevin Tritium Removal Facility (ILL-TRF), located at the Institute for Laue-Langevin in Grenoble. The ELL-TRF is the older of the two, having begun operation in 1973. The trip was arranged by Sulzer Winterthur who provided an French-speaking engineer, Vince Goyette, to accompany us. We discussed the present status of the ANS detritiation facility design and Sulzer's experience with the detritiation facilities that they have constructed, along with the design and operations experience of the ILL-TRF. In addition we visited Linde Kryotechnik, which until last year was part of Sulzer.

0702 Radiation Sources

Refer also to citation(s) 6930, 6932, 7083, 7342, 7884, 7885

6320 (CONF-9308122–12) **Ion implantation of diamond: Damage, doping, and lift-off.** Parikh, N.R. (North Carolina Univ., Chapel Hill, NC (United States). Dept. of Physics and Astronomy); McGucken, E.; Swanson, M.L.; Hunn, J.D.; White, C.W.; Zuhr, R.A. Oak Ridge National Lab., TN (United States). Sep 1993. 6p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC05-84OR21400. Contract N00014-92-C-0081. From International Union of Materials Research Societies on advanced materials; Tokyo (Japan); 31 Aug - 4 sep 1993. Order Number DE94001133. Source: OSTI; NTIS; GPO Dep.

In order to make good quality economical diamond electronic devices, it is essential to grow films and to dope these films to obtain n- and p- type conductivity. This review talk discuss first doping by ion implantation plus annealing of the implantation damage, and second flow to make large area single crystal diamonds. C implantation damage below an estimated Frenkel defect concentration of 7% could be recovered almost completely by annealing at 950C. For a defect concentration between 7 and 10%, a stable damage form of diamond ("green diamond") was formed by annealing. At still higher damage levels, the diamond graphitized. To introduce p-type doping, we have co-implanted B and C into natural diamond at 77K, followed by annealing up to 1100C. The resulting semiconducting material has electrical properties similar to those of natural B-doped diamond. To create n-type diamond, we have implanted Na^+, P+ and As^+ ions and have observed semiconducting behavior. This has been compared with carbon or noble element implantation, in an attempt to isolate the effect of radiation damage. Recently, in order to obtain large area signal crystals, we have developed a novel technique for removing thin layers of diamond from bulk or homoepitaxial films. This method consists of ion implantation, followed by selective etching. High energy (4–5 MeV) implantation of carbon or oxygen ions creates a well-defined layer of damaged diamond buried at a controlled depth. This layer is graphitized and selectivity etched either by heating at 550C in an oxygen ambient or by electrolysis. This process successfully lifts off the diamond plate above the graphite layer. The lift-off method, combined with well-established homoepitaxial growth processes, has potential for fabrication of large area single-crystal diamond sheets.

6321 (INIS-mf–13746, pp. 55) **Mechanism of the sensitization of radiation vulcanisation of rubber latex by mono-acrylates.** Hill, D.J.T. (Queensland Univ., St. Lucia, QLD (Australia). Polymer Materials and Radiation Group); O'Donnel, J.H.; Perera, M.C.S.; Pomery, P.J. Australian Inst. of Nuclear Science and Engineering, Lucas Heights, NSW (Australia). 1991. 94p. (CONF-9302158–: 1. Australian-Asian conference on radiation science and nuclear medicine, Sydney (Australia), 17-19 Feb 1993). In *The first Australian-Asian conference on radiation science and nuclear medicine: conference handbook.* Order Number DE94608511. Source: OSTI; NTIS (US Sales Only); INIS.

Short communication. 3 refs. ACRYLATES/radiosensitizers; LATEX/vulcanization; ACRYLATES; RADIOSENSITIZERS; ELECTRON SPIN RESONANCE; EXPERIMENTAL DATA; INFRARED SPECTRA; LATEX; VULCANIZATION; MONOMERS; RADIATION EFFECTS

6322 (LA-UR–93-4257) **Moderator materials and neutronic performance.** Daemen, L.L.; Russell, G.J.; Pitcher, E.J.; Lujan, M. Jr. Los Alamos National Lab., NM (United States). [1993]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9305177–14: 12. International collaboration of advanced neutron sources meeting (ICANS), Abingdon (United Kingdom), 24-28 May 1993). Order Number DE94004987. Source: OSTI; NTIS; INIS; GPO Dep.

The great variety of instruments proposed for LANSCE-II entails an equally varied set of requirements for the target stations moderators. Besides the obvious features such as intensity and pulse width of the neutron pulse, a number of more pragmatic questions have to be addressed such as fast neutron background and energy deposition in the moderators, especially at large proton beam powers such as the 1 MW proton beam power proposed for LANSCE-II.

6323 (ORNL/FTR–4815) **Travel to Europe to collaborate on neutron source research: Foreign trip report, October 2–12, 1993.** Lucas, A.T. Oak Ridge National Lab., TN (United States). 20 Oct 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94002469. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Useful production of cold neutrons requires a source incorporating a hydrogenous material temperature. The ANS will employ two liquid deuterium cold neutron sources operating at 20 K to illuminate seven experimental beam lines. Neutronic heating in a cold source material is roughly proportional to neutron flux intensity and each source in the ANS will represent a heat load of about 32 kW. This a factor of about five times that of the ILL which at the present time represents the highest neutron flux available. Operational experience gained from this reactor and its cold sources has had considerable influence on the ANS baseline design. I was able to discuss design features with the teams and their comments will be considered in detail as the cold source design progresses. The visit to PSI provided an opportunity to visit a new facility. Construction is well advanced and the visit provided useful discussions, directly relevant to the ANS. A cold source system was designed and built for the Munich reactor at the time of its inception about twenty years ago, but never installed. This system will now be installed in the reactor to help develop a cold source design for FRM-II, a new reactor which is currently being planned. The movement of personnel within the European community has resulted in a crossbreeding of ideas between various facilities and contact was made with people having experience with several different cold source systems. A pertinent result of the trip was an agreement to maintain personal contacts and share problems of the various cold sources, particularly those intended for high radiation fluxes.

6324 (ORNL/TM–12629) **Follow-up fuel plate stability experiments and analyses for the Advanced Neutron Source.** Swinson, W.F.; Battiste, R.L.; Luttrell, C.R.; Yahr, G.T. Oak Ridge National Lab., TN (United States). Nov 1993. 67p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94005471. Source: OSTI; NTIS; INIS; GPO Dep.

The reactor for the planned Advanced Neutron Source uses closely spaced plates cooled by heavy water flowing through narrow channels. Two sets of tests were performed on the upper and lower fuel plates for the structural response of the fuel plates to the required high coolant flow velocities. This report contains the data from the second round of tests. Results and conclusions from all of the tests are also included in this report. The tests were done using light water on full-scale epoxy models, and through model theory, the results were related to the prototype plates, which are aluminum-clad aluminum/uranium silicide involute-shaped plates.

0703 Isotopic Power Supplies

Refer also to citation(s) 6629

08 HYDROGEN

0801 Production

6325 (DOE/MC/27225–3540) **Biological conversion of synthesis gas: Quarterly report [No. 3-4, July 1, 1993–September 3, 1993].** Ackerson, M.D.; Clausen, E.C.; Gaddy, J.L. Arkansas Univ., Fayetteville, AR (United States). Dept. of Chemical Engineering. Oct 1993. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG21-90MC27225. Order Number DE94000066. Source: OSTI; NTIS; GPO Dep.

This report details the status of the Biological Conversion of Synthesis Gas Project. The following tasks are described as being completed: (1) the test plan, (2) culture development, and (3) the mass transfer/kinetic studies. The bioreactor studies (Task 4) are underway. The continuous stirred tank reactor system for the conversion of H_2S to elemental sulfur using Chlorobium thiosulfatophilum has been studied for varying light intensities. The system was also modified to include both sulfur recovery and cell recycle using ceramic membranes. Studies were also performed to observe the effects of cell recycle using a polysulfone hollow filter membrane module. Work on Task 5, limiting conditions/scale-up, includes a scale-up study with three different size reactors to establish the optimum operating conditions for hydrogen production from synthesis gas by the biological water-gas shift reaction using the photosynthetic bacterium Rhodospirillum rubrum. Finally, Task 6, an economic analysis, was performed for the H_2 production system using R. rubrum. The analyses show that biological H_2 production from syngas can be very economical if the light requirements for R. rubrum can be neglected.

6326 (EDF–93-NM-00028) **Hydrogen-powered vehicles.** Borel, P.; Mignard, B. Electricite de France (EDF), 92 - Clamart (France). Dec 1991. 16p. (In French). Order Number DE94728744. Source: OSTI; NTIS (US Sales Only).

The aim of this study is to propose and test a methodology for the assessment of liquid hydrogen production and distribution ways. Processes are assessed on the basis of three criteria, which are linked to energy-related, economic and environmental considerations. This method has been used for two ways of liquid hydrogen production and distribution: - hydrogen production by natural gas steam reforming; transportation of the hydrogen gas; liquefaction; storage of the liquid hydrogen; transportation of the liquid hydrogen in tankers; storage in the distribution station. - the second way is identical to the first, except that initial hydrogen production is by the electrolysis of water. (author).

0802 Storage, Transport, and Handling

6327 (NREL/CP–470-5777, pp. 63-77) **Nonclassical polyhydride metal complexes as hydrogen storage materials.** Jensen, C. (Univ. of Hawaii, Honolulu, HI (United States)). National Renewable Energy Lab., Golden, CO (United States). Aug 1993. (CONF-9305266–: 1993 Department of Energy/National Renewable Energy Laboratory (DOE/NREL) hydrogen program review, Cocoa Beach, FL (United States), 4-6 May 1993). In *Proceedings of the 1993 DOE/NREL Hydrogen Program Review.* 207p. Order Number DE93018207. Source: OSTI; NTIS.

An alternate class of metal hydrides, nonclassical polyhydride metal complexes, are being developed as hydrogen storage materials. Novel cobalt group nonclassical polyhydride complexes have been synthesized and characterized through multinuclear NMR spectroscopy and single crystal X-ray diffraction. The complexes undergo a rapid and highly reversible loss of H_2 in solution and the solid state. This process has been studied by variable temperature ^1H and ^{31}P NMR as well as FTIR spectroscopy. The energetics of the reversible loss of H_2 can be fine-tuned by small changes in the ligand environment such as the steric bulk of the phosphine ligands or variation of the halide. The observed trends in the kinetic and thermodynamic stabilities of the halide complexes can be explained by the I >Br >Cl trend in the donor strengths of the halide ligands and establishes the influence of this parameter on the stability of dihydrogen complexes. Novel ruthenium and cobalt hydride complexes which are stabilized by cyclopentadienyl ligands have also been synthesized and are being characterized. These complexes may possess significant weight percent available hydrogen contents.

6328 (NREL/CP–470-5777, pp. 137-149) **Magnesium alloys for high hydrogen storage capacity at low temperatures.** Srinivasan, S. (Texas A&M Univ., College Station, TX (United States)); Kumar, M.P.S.; Petrov, K.; Visintin, A.; Appleby, A.J. National Renewable Energy Lab., Golden, CO (United States). Aug 1993. (CONF-9305266–: 1993 Department of Energy/National Renewable Energy Laboratory (DOE/NREL) hydrogen program review, Cocoa Beach, FL (United States), 4-6 May 1993). In *Proceedings of the 1993 DOE/NREL Hydrogen Program Review.* 207p. Order Number DE93018207. Source: OSTI; NTIS.

The objectives of this project are to investigate promising alloys for hydrogen storage, in order to find systems with (i) optimal plateau pressures and high capacities (considerably higher than for the state-of-the-art systems, which is about 1 to 1.5%) at low temperatures; (ii) fast hydrogen absorption/desorption kinetics, by use of catalytic additives; (iii) high stabilities for long term utilization; and (iv) tolerant to small quantities of impurities. A major aspect of this task will involve investigation of magnesium-based alloy systems which, according to some preliminary reports, show promise of high storage capacities under ambient conditions. Preliminary experiments reveal that materials, prepared by mechanical alloying, show promise for hydrogen storage. The potential of this technique will be fully explored. The thermodynamic and kinetic parameters of the hydriding/dehydriding reactions of selected alloys will be evaluated using the Sievert apparatus and microcalorimetry, which have both been appropriately modified in our laboratory for this purpose. The expected benefits of the proposed research are that finding reasonably low cost alloys with hydrogen storage capacities of greater than two to three percent will resolve the problem of fuel storage for low temperature fuel cells (proton exchange membrane, alkaline), vitally needed as power sources for zero emission vehicles and other mobile applications.

09 BIOMASS FUELS

Refer also to citation(s) 7497

6329 (ETSU-R–74) **Annual report on the Renewable Energy Programme.** AEA Environment and Energy, Harwell (United Kingdom). 1993. 94p. Order Number DE94730460. Source: OSTI; NTIS (US Sales Only).

This report reviews progress during 1991/92 with the Government's Renewable Energy Programme managed by the Energy Technology Support Unit (ETSU) under contract to the Department of Energy (DEn). The privatisation of the UK's Electricity Supply Industry and the introduction of the Renewable Enegy Orders under the Non-Fossil Fuel Obligation (NFFO) have given a major boost to

some of the more promising renewable energy technologies - landfill gas, waste combustion and wind energy in particular. The NFFO has now become a powerful driving force in moving the renewables from the R and D stage through demonstration to commercial deployment. A consequence of this is that the programme managed by ETSU has been broadened in scope and content during this last year. It now embraces R and D, demonstration, marketing and promotion, NFFO project monitoring and a range of cross-technology commercialisation activities such as regional studies, planning guidance, financing mechanisms and environmental assessments. (author)

6330 (NREL/CP–200-5768-Vol.1, pp. 1-17) **Biomass: An overview in the United States of America.** Robertson, T. (USDA Soil Conservation Service, Washington, DC (United States)); Shapouri, H. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Concerns about the heavy reliance on foreign sources of fossil fuels, environmental impacts of burning fossil fuels, environmental impacts of agricultural activities, the need to find sustainable renewable sources of energy, and the need for a sustainable agricultural resource base have been driving forces for the development of biomass as a source of energy. The development of biomass conversion technologies, of high-yielding herbaceous and short-rotation woody biomass crops, of high-yielding food, feed, and fiber crops, and of livestock with higher levels of feed conversion efficiencies has made the transition from total reliance on fossil fuels to utilization of renewable sources of energy from biomass a reality. A variety of biomass conversion technologies have been developed and tested. Public utilities, private power companies, and the paper industry are interested in applying this technology. Direct burning of biomass and/or cofiring in existing facilities will reduce emissions of greenhouse and other undesirable gases. Legislation has been passed to promote biomass production and utilization for liquid fuels and electricity. Land is available. The production of short-rotation woody crops and perennial grasses provides alternatives to commodity crops to stabilize income in the agricultural sector. The production of biomass crops can also reduce soil erosion, sediment loadings to surface water, and agricultural chemical loadings to ground and surface water; provide wildlife habitat; increase income and employment opportunities in rural areas; and provide a more sustainable agricultural resource base.

6331 (NREL/CP–200-5768-Vol.1, pp. 42-53) **Energy from wood biomass: The experience of the Brazilian forest sector.** Couto, L. (Universidade Federal de Vicosa (Brazil)); Graca, L.R.; Betters, D.R. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Wood biomass is one of the most significant renewable sources of energy in Brazil. Fuelwood and charcoal play a very important role not only for household energy consumption but also for the cement, iron and steel industries. Wood is used as an energy source by the pulp and paper, composite board and other industries of the country, mainly for steam and electricity generation. Ethanol, ligninbased coke and methanol from wood were produced at experimental units in Brazil but were not implemented on a commercial scale. Currently, a new experimental plant using a technology developed in the US is being built in the state of Bahia to generate electricity from Eucalyptus. This technology is a Biomass Integrated Gasification/Gas Turbine process which is expected to make the use of wood biomass economically feasible for electricity generation. Forest plantations are the main source of wood biomass for energy consumption by the Brazilian industrial sector. Fiscal incentives in the 1960s helped the country to begin a massive reforestation program mainly using Eucalyptus and Pinus species. A native species, bracatinga (Mimosa scabrella) has also been used extensively for wood energy plantations in southern Brazil. Technical, economic, social and environmental impacts of these plantation forests are discussed along with a forecast of the future wood energy utilization in Brazil.

6332 (NREL/CP–200-5768-Vol.1, pp. 162-198) **Overview of feedstock research in the United States, Canada, and Brazil.** Ferrell, J. (Department of Energy, Washington, DC (United States)); Tardif, M.L.; Couto, L.; Garca, L.R.; Betters, D.; Ashworth, J. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

This is an overview of the current biomass feedstock efforts in Brazil, Canada, and the United States. The report from Brazil provides an historical perspective of incentive programs, the charcoal and fuelwood energy programs, the alcohol program, and other biomass energy efforts. The efforts in Brazil, particularly with the sugar cane to ethanol and the charcoal and fuelwood programs, dwarfs other commercial biomass systems in the Americas. One of the bright spots in the future is the Biomass Integrated Gasification/Gas Turbine Electricity Project initially funded in 1992. The sugar cane-based ethanol industry continues to develop higher yielding cane varieties and more efficient microorganisms to convert the sugar cane carbohydrates into alcohol. In Canada a number of important institutions and enterprises taking part in the economical development of the country are involved in biomass research and development including various aspects of the biomass such as forestry, agricultural, industrial, urban, food processing, fisheries and peat bogs. Biomass feedstock research in the United States is evolving to reflect Department of Energy priorities. Greater emphasis is placed on leveraging research with the private sector contributing a greater share of funds, for both research and demonstration projects. The feedstock program, managed by ORNL, is focused on limited model species centered at a regional level using a multidisciplinary approach. Activities include a stronger emphasis on emerging environmental issues such as biodiversity, sustainability and habitat management. DOE also is a supporter of the National Biofuels Roundtable, which is developing principles for producing biomass energy in an economically viable and ecologically sound manner. Geographical Information Systems are also being developed as tools to quantify and characterize the potential supply of energy crops in various regions.

0907 Resources

Refer also to citation(s) 6346, 6349, 6354, 6436, 6442, 6446, 6772

6333 (NREL/CP–200-5768-Vol.1, pp. 68-73) **Short-rotation forestry for energy production in Hawaii.** Phillips, V.C. (Univ. of Hawaii, Honolulu, HI (United States)); Liu, W.; Merriam, R.A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

In Hawaii, imports of fossil fuels continue to accelerate and now provide over 90% of the total energy supply at a cost exceeding $1 $\times 10^9$ annually exported from the local economy. Concurrently, sugarcane and pineapple crops, the traditional mainstays of the state's economy, have declined such that as much as 80,000 hectares of agricultural land are now available for alternative land uses. The feasibility of short-rotation forestry for sustainable energy production on these former sugarcane and pineapple plantation lands is being evaluated using species- and site-specific empirical models to predict yields of Eucalyptus grandis, E. saligna, and Leucaena leucocephala, a system model to estimate delivered costs, and a geographic information system to extend the analysis to areas where no field trials exist and to present results in map

form. The island of Hawaii is showcased as an application of the methodology. Modeling results of methanol, ethanol, and electricity production from tropical hardwoods are presented. Short-rotation forestry appears to hold promise for the greening of Hawaii's energy system and agricultural lands for the benefit of the state's citizens and visitors. The methodology is readily transferable to other regions of the United States and rest of the world.

6334 (NREL/CP–200-5768-Vol.1, pp. 79-87) **Forest biomass and energy-wood potential in the southern United States.** Saucier, J.R. (Forestry Sciences Lab., Athens, GA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Timber resource data were compiled from the most recent USDA Forest Service inventory data for the 12 Southern States from Virginia to Texas. Timber resource inventories traditionally include only trees 5 inches dbh and greater and their volumes to the prevailing merchantable top diameter expressed in cubic feet, board feet, or cords. For this paper, conversion factors were developed to express timber inventories in weight and to expand the inventories to include the crowns of merchantable trees and trees less than 5 inches dbh. By so doing, the total aboveground biomass is estimated for the timberlands in the South. The region contains 185 million acres of timberland. Some 14.6 billion green tons of woody biomass are present on southern timberland – about 79 tons per acre. When mature stands are harvested, the average acre in the South has 22.2 tons of woody material left in crowns and sapling, and 5.1 tons in cull stems. Thus, an average of 27.3 green tons per acre of potential energy wood are left after conventional harvests. Conversion factors that are presented permit estimates for specific tracts, areas, counties, or states.

6335 (NREL/CP–200-5768-Vol.1, pp. 88-93) **Biomass energy inventory and mapping system.** Kasile, J.D. (Ohio State Univ., Columbus, OH (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

A four-stage biomass energy inventory and mapping system was conducted for the entire State of Ohio. The product is a set of maps and an inventory of the State of Ohio. The set of amps and an inventory of the State's energy biomass resource are to a one kilometer grid square basis on the Universal Transverse Mercator (UTM) system. Each square kilometer is identified and mapped showing total British Thermal Unit (BTU) energy availability. Land cover percentages and BTU values are provided for each of nine biomass strata types for each one kilometer grid square. LANDSAT satellite data was used as the primary stratifier. The second stage sampling was the photointerpretation of randomly selected one kilometer grid squares that exactly corresponded to the LANDSAT one kilometer grid square classification orientation. Field sampling comprised the third stage of the energy biomass inventory system and was combined with the fourth stage sample of laboratory biomass energy analysis using a Bomb calorimeter and was then used to assign BTU values to the photointerpretation and to adjust the LANDSAT classification. The sampling error for the whole system was 3.91%.

6336 (NREL/CP–200-5768-Vol.1, pp. 94-99) **Biomass resources in California.** Tiangco, V.M. (California Energy Commission, Sacramento, CA (United States)); Sethi, P.S. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The biomass resources in California which have potential for energy conversion were assessed and characterized through the project funded by the California Energy Commission and the US Department of Energy's Western Regional Biomass Energy Program (WRBEP). The results indicate that there is an abundance of biomass resources as yet untouched by the industry due to technical, economic, and environmental problems, and other barriers. These biomass resources include residues from field and seed crops, fruit and nut crops, vegetable crops, and nursery crops; food processing wastes; forest slash; energy crops; lumber mill waste; urban wood waste; urban yard waste; livestock manure; and chaparral. The estimated total potential of these biomass resource is approximately 47 million bone dry tons (BDT), which is equivalent to 780 billion MJ (740 trillion Btu). About 7 million BDT (132 billion MJ or 124 trillion Btu) of biomass residue was used for generating electricity by 66 direct combustion facilities with gross capacity of about 800 MW. This tonnage accounts for only about 15% of the total biomass resource potential identified in this study. The barriers interfering with the biomass utilization both in the on-site harvesting, collection, storage, handling, transportation, and conversion to energy are identified. The question whether these barriers present significant impact to biomass "availability" and "sustainability" remains to be answered.

6337 (NREL/CP–200-5768-Vol.1, pp. 100-105) **Finnish bioenergy research.** Malinen, H. (Technical Research Centre of Finland, Jyvaeskylae (Finland)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Finland is one of the leading countries in the use of biofuels. The share of wood derived fuels of the total primary energy requirement was about 14% (ca. 4 million toe) and peat about 5% (1.4 million toe). The possibilities for increasing the use of biofuels in Finland are significant. There is theoretically about 10 million m^3/a (about 2 million toe/a) of harvestable wood. Areas suitable for fuel peat production (0.5 million ha) could produce ca. 420 million toe of peat. At present rates of use, the peat reserves are adequate for centuries. During the next few years 0.5–1 million hectares of fields withdrawn from farming could be used for biofuel production. The production potential of this field area is estimated to be about 0.2–0.5 million toe. In addition, the use of wastes in energy production could be increased. The aim of the new Bioenergy Research Programme is to increase the use of economically profitable and environmentally sound bioenergy by improving the competitiveness of present peat and wood fuels. New economically competitive biofuels, new equipment and methods for production, handling and use of biofuels will also be developed. The main research areas are production of wood fuels, peat production, use of bioenergy and conversion of biomass.

6338 (NREL/CP–200-5768-Vol.1, pp. 112-125) **Energy conversion of animal manures: Feasibility analysis for thirteen western states.** Whittier, J. (NEOS Corp., Lakewood, CO (United States)); Haase, S.; Milward, R.; Churchill, G.; Searles, M.B.; Moser, M.; Swanson, D.; Morgan, G. National Renewable Energy Lab., Golden, CO (United States). [1993]. DOE Contract AC65-90WA05637. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The growth and concentration of the livestock industry has led to environmental disposal problems for large quantities of manure at feedlots, dairies, poultry production plants, animal holding areas and pasturelands. Consequently, waste management systems that facilitate energy recovery are becoming increasingly attractive since they address pollution problems and allow for energy generation from manure resources. This paper presents a manure resource assessment for the 13 US Department of Energy, Western Regional Biomass Energy Program states, describes and

evaluates available energy conversion technologies, identifies environmental and regulatory factors associated with manure collection, storage and disposal, and identifies common disposal practices specific to animal types and areas within the WRBEP region. The paper also presents a pro forma economic analysis for selected manure-to-energy conversion technologies. The annual energy potential of various manures within the WRBEP region is equivalent to approximately 111×10^{13} Btu. Anaerobic digestion systems, both lagoon and plug flow, offer positive economic returns in a broad range of utility service territories.

6339 (NREL/CP–200-5768-Vol.1, pp. 126-142) **Cotton gin trash in the western United States: Resource inventory and energy conversion characterization.** Haase, S.G. (NEOS Corp., Lakewood, CO (United States)); Quinn, M.W.; Whittier, J.P.; Cohen, T.M.; Lansford, R.R.; Craig, J.D.; Swanson, D.S.; Morgan, G. National Renewable Energy Lab., Golden, CO (United States). [1993]. DOE Contract AC65-90WA05637. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The disposal of wastes associated with the processing of cotton is posing increasing problems for cotton gin operators in the western United States. Traditional disposal methods, such as open-air incineration and landfilling are no longer adequate due to increasing environmental concerns. This paper evaluates the technical, economic and environmental feasibility for cotton gin trash to serve as an energy resource. Cotton gin trash has been quantified, by county, in the five cotton-growing states of the western United States. The energy conversion technology that appears to offer the most promise is gasification. An economic evaluation model has been developed that will allow gin operators to analyze their own situation to determine the profitability of converting gin trash to energy.

6340 (NREL/CP–200-5768-Vol.1, pp. 284-289) **Understory biomass from southern pine forests as a fuel source.** Ku, T.T. (Univ. of Arkansas, Monticello, AR (United States)); Baker, J.B. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The energy crisis in the US in the late 1970s led to accelerated research on renewable energy resources. The use of woody biomass, harvested from pine forests in the southern US, as a renewable energy source would not only provide an efficient energy alternative to forest industries, but its use would also reduce understory competition and accelerate growth of overstory crop trees. This study was initiated in the early 1980s to investigate the feasibility and applicability of the use of understory vegetation as a possible energy fuel resource. All woody understory vegetation [<14 cm (<5.5 in) in dbh], on 0.2 ha (0.5 ac) plots that represented a range of stand/site conditions of pine stands located in twelve southern Arkansas counties and two northern Louisiana parishes were characterized, quantified, and harvested. Based on the biomass yield from 720 subplots nested within 40 main plots, the top five dominant species in the understory, based on number and size were: Red maple, red oaks, pines, sweetgum, and winged elm. Some other species occurring, but in smaller proportions, were flowering dogwood, beautyberry, white oaks, black gum, wax myrtle, hickories, persimmon, and ashes. Most of these species are deciduous hardwoods that provide high BTU output upon burning. The average yield of chipped understory biomass was 23.5 T/ha with no difference occurring between summer and winter harvests. A predictive model of understory biomass production was developed using a step-wise multivariate regression analysis. In relation to forest type, high density pine stands produced 53% more understory biomass than high density pine-hardwood stands. The average moisture content of biomass was significantly lower when harvested in winter than when harvested in summer.

6341 (NREL/CP–200-5768-Vol.1, pp. 314-319) **Compatibility of switchgrass as an energy crop in farming systems of the southeastern USA.** Bransby, D.I. (Auburn Univ., AL (United States)); Rodriguez-Kabana, R.; Sladden, S.E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The objective of this paper is to examine the compatibility of switchgrass as an energy crop in farming systems in the southeastern USA, relative to other regions. In particular, the issues addressed are (1) competition between switchgrass as an energy crop and existing farm enterprises, based primarily on economic returns, (2) complementarity between switchgrass and existing farm enterprises, and (3) environmental benefits. Because projected economic returns for switchgrass as an energy crop are highest in the Southeast, and returns from forestry and beef pastures (the major existing enterprises) are low, there is a very strong economic incentive in this region. In contrast, based on current information, economic viability of switchgrass as an energy crop in other regions appears doubtful. In addition, switchgrass in the southeastern USA would complement forage-livestock production, row crop production and wildlife and would provide several additional environmental benefits. It is concluded that the southeastern USA offers the greatest opportunity for developing switchgrass as an economically viable energy crop.

6342 (NREL/CP–200-5768-Vol.1, pp. 440-447) **Wood power in North Carolina.** Cleland, J.G. (Research Triangle Institute, Research Triangle Park, NC (United States)); Guessous, L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

North Carolina (NC) is one of the most forested states, and supports a major wood products industry. The NC Department of Natural Resources sponsored a study by Research Triangle Institute to examine new, productive uses of the State's wood resources, especially electric power generation by co-firing with coal. This paper summarizes our research of the main factors influencing wood power generation opportunities, i.e., (1) electricity demand; (2) initiative and experience of developers; (3) available fuel resources; (4) incentives for alternate fuels; and (5) power plant technology and economics. The results cover NC forests, short rotation woody crops, existing wood energy facilities, electrical power requirements, and environmental regulations/incentives. Quantitative assessments are based on the interests of government agencies, utilities, electric cooperatives, developers and independent power producers, forest products industries, and the general public. Several specific, new opportunities for wood-to-electricity in the State are identified and described. Comparisons are made with nationwide resources and wood energy operations. Preferred approaches in NC are co-generation in existing or modified boilers and in dedicated wood power plants in forest industry regions. Co-firing is mainly an option for supplementing unreliable primary fuel supplies to existing boilers.

0908 Production

Refer also to citation(s) 6333, 6446, 6886

6343 (NREL/CP–200-5768-Vol.1, pp. 143-148) **Systems for harvesting and handling cotton plant residue.** Coates, W. (Univ. of Arizona, Tucson, AZ (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the*

Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1. 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

In the warmer regions of the United States, cotton plant residue must be buried to prevent it from serving as an overwintering site for insect pests such as the pink bollworm. Most of the field operations used to bury the residue are high energy consumers and tend to degrade soil structure, thereby increasing the potential for erosion. The residue is of little value as a soil amendment and consequently is considered a negative value biomass. A commercial system to harvest cotton plant residue would be of both economic and environmental benefit to cotton producers. Research has been underway at the University of Arizona since the spring of 1991 to develop a commercially viable system for harvesting cotton plant residue. Equipment durability, degree of densification, energy required, cleanliness of the harvested material, and ease of product handling and transport are some of the performance variables which have been measured. Two systems have proven superior. In both, the plants are pulled from the ground using an implement developed specifically for the purpose. In one system, the stalks are baled using a large round baler, while in the other the stalks are chopped with a forage harvester, and then made into packages using a cotton module maker. Field capacities, energy requirements, package density and durability, and ease of handling with commercially available equipment have been measured for both systems. Selection of an optimum system for a specific operation depends upon end use of the product, and upon equipment availability.

6344 (NREL/CP–200-5768-Vol.1, pp. 149-155) **Collection and hauling of cereal grain chaff.** Reding, B. (Prairie Agricultural Machinery Institute, Humboldt, Saskatchewan (Canada)); Leduc, P.; Stumborg, M. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Cereal grain chaff has been identified by Energy Mines and Resources, Canada, and Agriculture Canada, as a suitable feedstock for ethanol production. Canada produces 13,300,000 t (14,600,000 ton) of cereal grain chaff annually; mainly in the prairie region. Work conducted at the Prairie Agricultural Machinery Institute (PAMI), Humboldt, Saskatchewan, has determined that the collection of chaff for centralized processing is a problem due to low bulk density in its natural state. This problem can be overcome by densification using either compression or size reduction. Either method will be economical in a chaff shed radius of 140 km (87 mi) when chaff is densified to 160 kg/m^3 (10 lb/ft^3). The size reduction method of densification may be economical to hauling distances exceeding 166 km (103 mi), particularly if size reduction is a required part of ethanol processing. Further work is under way to develop the required equipment modifications to allow existing farm equipment to be used for this purpose.

6345 (NREL/CP–200-5768-Vol.1, pp. 199-213) **Willow bioenergy plantation research in the Northeast.** White, E.H. (SUNY College of Environmental Science and Forestry, Syracuse, NY (United States)); Abrahamson, L.P.; Kopp, R.F.; Nowak, C.A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Experiments were established in Central New York in the spring of 1987 to evaluate the potential of Salix for biomass production in bioenergy plantations. Emphasis of the research was on developing and refining establishment, tending and maintenance techniques, with complimentary study of breeding, coppice physiology, pests, nutrient use and bioconversion to energy products. Current yields utilizing salix clones developed in cooperation with the University of Toronto in short-rotation intensive culture bioenergy plantations in the Northeast approximate 8 oven dry tons per acre per year with annual harvesting. Successful clones have been identified and culture techniques refined. The results are now being integrated to establish a 100 acre Salix large-scale bioenergy farm to demonstrate current successful biomass production technology and to provide plantations of sufficient size to test harvesters; adequately assess economics of the systems; and provide large quantities of uniform biomass for pilot-scale conversion facilities.

6346 (NREL/CP–200-5768-Vol.1, pp. 214-221) **The role and significance of Salix plantations for energy in Swedish agriculture.** Forsse, L.S. (Swedish Univ. of Agricultural Sciences, Uppsala (Sweden)); Ledin, S.; Johansson, H. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Fifteen years of research and development of energy forestry with Salix species has lead to a firm basis of knowledge concerning the basic biology, stand ecology and production systems of fast growing willows in Sweden. The biology research program continues to emphasize studies of plant biology and diseases as well as areas such as clone/site interactions, mixed clonal plantations and breeding. The technological research and development concentrates on functional and effective machinery for planting, harvesting, etc. Recently Salix plantations for energy production in Sweden have been commercialized. Plantations start with 18,000 cuttings of willow clones per hectare. During the first summer weed control is the most important treatment. Fertilizers are applied to keep a high production level. Crops are harvested during winter at 3–5 year intervals. The average annual production is about 10–12 tonnes DM per hectare. The life of Salix plantations is estimated as 25–30 years. An estimated potential of 300,000 hectares of Salix plantations would result 5% of the energy needs in Sweden. Wood fuel from the conventional forest equals 60 TWh today, with a potential of being doubled within 10–20 years. The economic outcome for the farmer of growing Salix mainly depends on the price of chips and the level of production. A fundamental requirement for establishing plantations is that there is a wood fuel market within a reasonable distance (about 50 km). In a calculation stretching over a period of 24 years with a production level of 12 tonnes DM per hectare and year, and at an interest rate of 6%, the net return is about 1,000–1,500 SEK/ha/yr (about 7 SEK/US$) if simultaneous chipping is used. With separate harvest and chipping and enterprise in this calculation breaks even. Interest in the utilization of sludge, ash, waste water and leakage water as nutrients for energy forests is increasing from local and regional authorities.

6347 (NREL/CP–200-5768-Vol.1, pp. 222-228) **From research plots to prototype biomass plantations.** Kenney, W.A. (Univ. of Toronto, Ontario (Canada)); Vanstone, B.J.; Gambles, R.L.; Zsuffa, L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The development of biomass energy plantations is now expanding from the research plot phase into the next level of development at larger scale plantings. This is necessary to provide: more accurate information on biomass yields, realistic production cost figures, venues to test harvesting equipment, demonstration sites for potential producers, and a supply of feedstock for prototype conversion facilities. The paper will discuss some of these objectives and some of the challenges encountered in the scale-up process associated with a willow prototype plantation project currently under development in Eastern Canada.

6348 (NREL/CP–200-5768-Vol.1, pp. 229-234) **Compatibility of switchgrass as an energy crop in farming systems of the southeastern USA.** Bransby, D.I. (Auburn Univ., AL (United States)); Rodriguez-Kabana, R.; Sladden, S.E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy,

environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The objective of this paper is to examine the compatibility of switchgrass as an energy crop in farming systems in the southeastern USA, relative to other regions. In particular, the issues addressed are (1) competition between switchgrass as an energy crop and existing farm enterprises, based primarily on economic returns, (2) complementarity between switchgrass and existing farm enterprises, and (3) environmental benefits. Because projected economic returns for switchgrass as an energy crop are highest in the Southeast, and returns from forestry and beef pastures (the major existing enterprises) are low, there is a very strong economic incentive in this region. In contrast, based on current information, economic viability of switchgrass as an energy crop in other regions appears doubtful. In addition, switchgrass in the southeastern USA would complement forage-livestock production, row crop production and wildlife and would provide several additional environmental benefits. It is concluded that the southeastern USA offers the greatest opportunity for developing switchgrass as an economically viable energy crop.

6349 (NREL/CP–200-5768-Vol.1, pp. 235-247) **Integrated production of warm season grasses and agroforestry for biomass production.** Samson, R. (Resource Efficient Agricultural Production-Canada, Ste. Anne de Bellevue, Quebec (Canada)); Omielan, J.; Girouard, P.; Henning, J. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Increased research on C_3 and C_4 perennial biomass crops is generating a significant amount of information on the potential of these crops to produce large quantities of low cost biomass. In many parts of North America it appears that both C_3 and C_4 species are limited by water availability particularly on marginal soils. In much of North America, rainfall is exceeded by evaporation. High transpiration rates by fast growing trees and rainfall interception by the canopy appear to indicate that this can further exacerbate the problem of water availability. C_4 perennial grasses appear to have distinct advantages over C_3 species planted in monoculture systems particularly on marginal soils. C_4 grasses historically predominated over much of the land that is now available for biomass production because of their adaptation to low humidity environments and periods of low soil moisture. The planting of short rotation forestry (SRF) species in an energy agroforestry system is proposed as an alternative production strategy which could potentially alleviate many of the problems associated with SRF monocultures. Energy agroforestry would be complementary to both production of conventional farm crops and C_4 perennial biomass crops because of beneficial microclimatic effects.

6350 (NREL/CP–200-5768-Vol.1, pp. 248-253) **Switchgrass as a biofuels crop for the upper Southeast.** Parrish, D.J. (Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (United States)); Wolf, D.D. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Switchgrass (Panicum virgatum) has been identified in DOE-sponsored studies as a widely adapted, productive herbaceous candidate for biofuels cropping. It is a perennial that has been planted using no-till procedures, and it appears to have positive effects on the soils in which it grows. We have been looking at this species as a potential fuelcrop (as well as a valuable forage) for several years. In this presentation, we note several "lessons learned" about switchgrass establishment and management as an energy crop. Data include results from recent plantings in the upper Southeast USA and from cutting management studies. Six varieties of switchgrass (Alamo, Cave-in-Rock, Kanlow, Shelter, and two breeder's lines) varied markedly in the success of their no-till establishment at eight locations across the upper Southeast. Better weed control, which was achieved at later planting dates, seemed to be the key. Yields obtained in the establishment stands revealed that two harvests per season are more productive (by 2 to 3 Mg/ha) than one, but the date of first cutting is crucial. First cutting should be from late-June to mid-July. A two-cut system may not be economically advantageous, however. Another cutting-management study detected losses of standing biomass at the end of the growing season. As much as 15% of the above-ground biomass present in early-September was no longer harvestable in early-November. We think this loss results from translocation of dry matter to below-ground parts.

6351 (NREL/CP–200-5768-Vol.1, pp. 254-259) **Production of biomass/energy crops on phosphatic clay soils in central Florida.** Stricker, J.A. (Univ. of Florida, Bartow, FL (United States)); Prine, G.M.; Woodard, K.R.; Anderson, D.L.; Shibles, D.B.; Riddle, T.C. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Phosphatic clay is a byproduct of phosphate mining. Presently more than 40,470 ha have been created, most in central Florida, and about 810 ha are being added each year. Phosphatic clays have high fertility and high water holding capacity, reducing fertilization costs and producing high yields without irrigation. Based on 10 years of research, scientists have selected tall annual-regenerating perennial C-4 grasses as having the greatest potential for biomass production in Florida. The purpose of this work was to determine the feasibility of growing these tall perennial grasses for biomass on phosphatic clay. Elephantgrass, sugarcane and energycane, and erianthus were planted in duplicate replications on phosphatic clay soil in late August, 1986. yield was measured by one harvest in December or January each year for four years. Nitrogen fertilization included 112 kg ha^{-1} the first year followed by 134 kg ha^{-1} for the next three years. Nitrogen is the only supplemental nutrient needed to grow all tall grass crops on phosphatic clay. The average annual oven dry matter yield over the 4-yr period was 36.3 Mg ha^{-1} for PI 300086 elephantgrass, 45.2 for N51 elephantgrass, 42.5 for L79-1002 energycane, 49.0 for US72-1153 energycane, 49.7 for US78-1009 sugarcane, 52.2 for US56-9 sugarcane, 56.2 for CP72-1210 sugarcane, and 48.8 for 1K-7647 erianthus. More recent work has utilized domestic sewage sludge as a nitrogen source for the tall grasses. Preliminary sugar yields of selected sugarcane accessions & sweet sorghum were 4.7 Mg ha^{-1} for CP72-1210, 12.5 for US67-2022, 3.4 for US78-1009 and 1.3 Mg ha^{-1} for sweet sorghum. The high yields of the tall grasses grown on phosphatic clay with low inputs indicate a great potential for these crops as a source of renewable energy. A sustainable cropping system may be maintained by utilizing municipal sewage sludge as a nitrogen source with tall grasses on phosphatic clay.

6352 (NREL/CP–200-5768-Vol.1, pp. 260-264) **Space/age forestry: Implications of planting density and rotation age in SRIC management decisions.** Merriam, R.A.; Phillips, V.D.; Liu, W. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Short-rotation intensive-culture (SRIC) of promising tree crops is being evaluated worldwide for the production of methanol, ethanol, and electricity from renewable biomass resources. Planting density and rotation age are fundamental management decisions associated with SRIC energy plantations. Most studies of these variables have been conducted without the benefit of a unifying theory of the

effects of growing space and rotation age on individual tree growth and stand level productivity. A modeling procedure based on field trials of Eucalyptus spp. is presented that evaluates the growth potential of a tree in the absence and presence of competition of neighboring trees in a stand. The results of this analysis are useful in clarifying economic implications of different growing space and rotation age decisions that tree plantation managers must make. The procedure is readily applicable to other species under consideration for SRIC plantations at any location.

6353 (NREL/CP–200-5768-Vol.1, pp. 265-271) **An optimal staggered harvesting strategy for herbaceous biomass energy crops.** Bhat, M.G. (Univ. of Tennessee, Knoxville, TN (United States)); English, B.C. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Biofuel research over the past two decades indicates lignocellulosic crops are a reliable source of feedstock for alternative energy. However, under the current technology of producing, harvesting and converting biomass crops, the cost of biofuel is not competitive with conventional biofuel. Cost of harvesting biomass feedstock is a single largest component of feedstock cost so there is a cost advantage in designing a biomass harvesting system. Traditional farmer-initiated harvesting operation causes over investment. This study develops a least-cost, time-distributed (staggered) harvesting system for example switch grass, that calls for an effective coordination between farmers, processing plant and a single third-party custom harvester. A linear programming model explicitly accounts for the trade-off between yield loss and benefit of reduced machinery overhead cost, associated with the staggered harvesting system. Total cost of producing and harvesting switch grass will decline by 17.94 percent from conventional non-staggered to proposed staggered harvesting strategy. Harvesting machinery cost alone experiences a significant reduction of 39.68 percent from moving from former to latter. The net return to farmers is estimated to increase by 160.40 percent. Per tonne and per hectare costs of feedstock production will decline by 17.94 percent and 24.78 percent, respectively. These results clearly lend support to the view that the traditional system of single period harvesting calls for over investment on agricultural machinery which escalates the feedstock cost. This social loss to the society in the form of escalated harvesting cost can be avoided if there is a proper coordination among farmers, processing plant and custom harvesters as to when and how biomass crop needs to be planted and harvested. Such an institutional arrangement benefits producers, processing plant and, in turn, end users of biofuels.

6354 (NREL/CP–200-5768-Vol.1, pp. 278-283) **Herbaceous energy crops in humid lower South USA.** Prine, G.M. (Univ. of Florida, Gainesville, FL (United States)); Woodard, K.R. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The humid lower South has the long warm growing season and high rainfall conditions needed for producing high-yielding perennial herbaceous grasses and shrubs. Many potential biomass plants were evaluated during a ten-year period. Perennial tall grasses such as elephantgrass (Pennisetum purpureum), sugarcane and energycane (Saccharum spp.) and the leguminous shrub Leucaena leucocephala were the highest in biomass production. These perennial crops often have top growth killed by winter freezes and regenerate from underground parts. The tall grasses have high yields because of linear crop growth rates of 18 to 27 g m^2 d^{-1} for long periods (140 to 196 d) each season. Tall grasses must be planted vegetatively, which is more costly than seed propagation, however, once established, they may persist for many seasons. Oven dry biomass yields have varied from 20 to 45 Mg ha^{-1} yr^{-1} in colder subtropical to mild temperate locations to over 60 Mg ha^{-1} yr^{-1} in the lower portion of the Florida peninsular. Highest biomass yields have been produced when irrigated with sewage effluent or when grown on phosphatic clay and muck soils in south Florida. The energy content of 1 Mg of oven dry tall grass and leucaena is equivalent to that of about 112 and 123 gallons of number 2 diesel fuel, respectively.

6355 (NREL/CP–200-5768-Vol.1, pp. 290-295) **MASSAHAKE whole tree harvesting method for pulp raw-material and fuel – R&D in 1993–1998.** Asplund, D.A. (Technical Research Centre of Finland, Jyvaeskylae (Finland)); Ahonen, M.A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

In Finland biofuels and hydropower are the only indigenous fuels available. Peat, wood and wood derived fuels form about 18% of total primary energy requirement. The largest wood and wood fuel user in Finland is wood processing industry, paper, pulp, sawmills. Due to silvicultural activities the growth of forests has developed an instant need for first thinnings. This need is about 12% of total stem wood growth. With conventional harvesting methods this would produce about 8 mill. m^3 pulp raw material and 2 mill. m^3 wood fuel. By using integrated harvesting methods about 12 mill. m^3 pulp raw material and 8 mill. m^3 (about 1, 3 mill. toe) fuel could be produced. At the moment, there is no economically profitable method for harvesting first thinning trees for industrial use or energy production. Hence, there are a few ongoing research projects aiming at solving the question of integrated harvesting. MASSAHAKE chip purification method has been under R&D since 1987. Research with continuous experimental line (capacity 5–10 loose-m^3) has been done in 1991 and 1992. The research has concentrated on pine whole tree chip treatment, but preliminary tests with birch whole tree chips has been done. The experiment line will be modified for birth whole tree chips during 1993. Based on the research results more than 60% of the whole tree chips can be separated to pulp raw material with < 1% bark content. This amount is 1.5–2 times more than with present technology. The yield of fuel fraction is 2–4 times higher compared to present methods. Fuel fraction is homogeneous and could be used in most furnaces for energy production. By replacing fossil fuels with wood fuel in energy production it is possible to reduce CO_2-emissions significantly. This paper presents the wood fuel research areas in Finland and technical potential of MASSAHAKE-method including the plant for building a demonstration plant based on this technology.

6356 (NREL/CP–200-5768-Vol.1, pp. 296-301) **Nutrient enhanced short rotation coppice for biomass in central Wales.** Hodson, R.W. (Univ. of Wales (United Kingdom)); Slater, F.M.; Lynn, S.F.; Randerson, P.F. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Two projects involving short rotation willow coppice are taking place on the eastern side of the Cambrian Mountains in central Wales. One project examines, as an alternative land use, the potential of short rotation willow coppice variously enhanced by combinations of lime, phosphorous and potassium fertilizers and also digested sewage sludge on an acidic upland site at an altitude of 260m. The first year results of this project are described in detail, showing the necessity for limestone additions and also demonstrating that of the four willow varieties established, Salix dasyclados is the only possible, profitable fuel crop. The other project involving willow in a filter bed system is outlined along with an additional project investigating the effect of sewage sludge additions on the Rubus fruticosus production in a birch dominated mixed deciduous woodland.

6357 (NREL/CP–200-5768-Vol.1, pp. 302-308) **Development and analysis of SRIC harvesting systems.** Stokes, B.J. (Southern Forest Experiment Station, Auburn, AL (United States)); Hartsough, B.R. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

This paper reviews several machine combinations for harvesting short-rotation, intensive-culture (SRIC) plantations. Productivity and cost information for individual machines was obtained from published sources. Three felling and skidding systems were analyzed for two stands, a 7.6-cm (3-in) average d.b.h. sycamore and a 15.2-cm (6-in) average d.b.h. eucalyptus. The analyses assumed that whole trees were chipped at roadside. Costs and production were summarized for each system. The systems were: (1) Continuous-travel feller-buncher, skidder, and chipper; (2) 3-wheel feller-buncher, skidder, and chipper; (3) chainsaw, skidder, and chipper. In the 7.6-cm stand, system productivities were 9.9, 7.3, and 7.5 BDLT/SMH, and costs were $20.9, $20.8, and $18.0 per BDLT for the three systems, respectively. System production rates for the 15.2-cm stand were 24.3, 10.2, and 12.5 BDLT/SMH, and costs were $8.7, $10.9, and $13.2 for systems 1, 2 and 3, respectively.

6358 (NREL/CP–200-5768-Vol.1, pp. 320-325) **Five years of research in energy plantation in southern Quebec (Canada).** Labrecque, M. (Jardin Botanique de Montreal, Quebec (Canada)); Teodorescu, T.I. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Since 1989, short rotation and intensive culture (SRIC) techniques have been experimented to grow various fast growing species of trees and shrubs for energy plantation or environmental purposes. The objectives were to evaluate the biomass productivity with respect to (1) different weed control methods during the establishment phase; (2) drainage conditions and soil quality of the plantation site; and (3) frequency of coppicing. Native or introduced species of willows and various species of shrubs, such as honeysuckle and cornel, were grown in an experimental design in the nursery of the Montreal Botanical Garden on former agricultural land. Productivity, in tons of dry material per hectare, was evaluated and compared by harvesting shoot and branch samples at the end of each growing season. Weed control is essential to the establishment of trees in SRIC. When weed repression was applied during the two first growing seasons, biomass productivity was 4 to 5 times greater than the biomass produced on the control plot of the well drained site. With good weed control, willows can yield more than 20 tons of dry material on well drained site and near 15 tons on a poorly drained site, only two years after plantation. The growth potential of shrub species is also interesting. Some of them were able to produce up to 10 tons of dry biomass per hectare per year, which is appreciable considering that such species can be used on marginal lands and for the fixation of river banks. Frequency of coppicing also influences productivity. For willows, we determined that three-year rotation cycle allowed the highest biomass productivity. Shrubs should be coppiced each year to obtain the best results. Fast growing species and SRIC techniques are not only a good way of producing wood and alcohol for energy but they also represent a way of rapidly colonizing degraded or marginal sites and of fixing river banks.

6359 (NREL/CP–200-5768-Vol.2, pp. 1409-1415) **Sweet sorghum cropping systems for on-farm ethanol or lactic acid.** Anderson, I.C. (Iowa State Univ., Ames, IA (United States)); Buxton, D.R.; Hunter, E.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Thirteen cropping systems using biomass crops in monoculture, double cropping, and intercropping were conducted with four rates of N for five years at two sites. Total above ground biomass was harvested and removed. Alfalfa and sweet sorghum removed the greatest amounts of K and had the lowest soil test K values after 5 years. Switchgrass removed the least K; about one-half as much as sweet sorghum. Reed canarygrass required the greatest rates of N and monocropped sweet sorghum the least (70 kg ha^{-1}). Sweet sorghum yielded up to 26 Mg ha^{-1} and contained 11 Mg ha^{-1} of cellulosic fibers and 7 Mg ha^{-1} of soluble sugars. Methods of fermenting sugars and fibers are discussed.

6360 (NREL/CP–200-5768-Vol.2, pp. 1427-1440) **Food, fuel, and feed production with microalgae.** Benemann, J.R. (Sea-Ag, Inc., Vero Beach, FL (United States)); Weissman, J.C. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Large-scale (>10 hectares) microalgae cultures are being used in several countries around the world for the production of human food supplements and specialty animal (mainly aquaculture) feeds. Microalgae cultures are also extensively used in wastewater treatment and being produced on a small scale for soil inoculants and diagnostic reagents. In addition, microalgae cultures are being investigated for their potential in fuel production and CO_2 utilization, as a method for greenhouse gas mitigation. A pilot plant effort in New Mexico, under a US Department of Energy/National Renewable Energy Lab. subcontract, demonstrated the feasibility of cultivating a number of algal species in large outdoor ponds on brackish waters. Building on this experience, SeaAg, Inc. has developed a process for the mass culture of microalgae as a source of bivalve feeds. In this process, algae (diatoms) are cultured in large open ponds on seawater, and then fed to clams and oysters, which filter and convert the algal cells into high value protein. The SeaAg process is another application of a technology which promises to eventually result in large-scale commercial production of microalgae for a variety of useful products and processes.

6361 (NREL/CP–200-5768-Vol.2, pp. 1472-1484) **The growth and harvesting of kenaf and its conversion to products: Case history of an industrial biomass crop.** Taylor, C.S. (Kenaf International Ltd., McAllen, TX (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Kenaf's story is now being told in the fields of South Texas and Southern Louisiana as new fiber processing operation are responding to the public's demand for more environmentally sound sources of fiber and farmer's desperate pleas for additional production options. Despite the title, this paper focuses primarily on the "demand" pull from the market place that brings the new crop production/processing system together. Kenaf, an annual hibiscus crop, has been cultivated for several centuries in Asia and Africa, mostly as a substitute for jute fiber in the world's cordage industry. The crop was first seriously considered in the Americas when jute supplies from Asia were cut off by the War in the Pacific. In the 1960s the US Department of Agriculture selected kenaf as the most promising annual crop source of fiber for the pulp and paper industry. Industry took a look but it wasn't their priority and the initial USDA effort ceased in the late 1970s. However, almost at the same time some newspaper publishers, who had been following the USDA work, intervened to keep things going. Kenaf International was formed in 1981 as system-oriented company determined to finally put things together on a commercial basis. The company focused

on both ends (market and production), hoping to fill in the middle as it went forward. The primary objective at first was to introduce kenaf as an annually renewable fiber source for newsprint manufacturers. That eventually proved to be a very big bite for a small organization to chew, and Kenaf International (and its associates) soon "discovered" other aspects of kenaf's potential as it pursued its goals. This is where we join The Kenaf Story "in progress."

6362 (ORNL–6781) **Biofuels feedstock development program: Annual progress report for 1992.** Wright, L.L.; Cushman, J.H.; Ehrenshaft, A.R.; McLaughlin, S.B.; McNabb, W.A.; Martin, S.A.; Ranney, J.W.; Tuskan, G.A.; Turhollow, A.F. Oak Ridge National Lab., TN (United States). Nov 1993. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004726. Source: OSTI; NTIS; INIS; GPO Dep.

Environmental Sciences Division Publication No. 4196.

The Department of Energy's (DOE's) Biofuels Feedstock Development Program (BFDP) leads the nation in the research, development, and demonstration of environmentally acceptable and commercially viable dedicated feedstock supply systems (DFSS). The purpose of this report is to highlight the status and accomplishments of the research that is currently being funded by the BFDP. Highlights summarized here and additional accomplishments are described in more detail in the sections associated with each major program task. A few key accomplishments include (1) development of a methodology for doing a cost-supply analysis for energy crops and the application of that methodology to looking at possible land use changes around a specific energy facility in East Tennessee; (2) preliminary documentation of the relationship between woody crop plantation locations and bird diversity at sites in the Midwest, Canada, and the pacific Northwest supplied indications that woody crop plantations could be beneficial to biodiversity; (3) the initiation of integrated switchgrass variety trials, breeding research, and biotechnology research for the south/southeast region; (4) development of a data base management system for documenting the results of herbaceous energy crop field trials; (5) publication of three issues of Energy Crops Forum and development of a readership of over 2,300 individuals or organizations as determined by positive responses on questionnaires.

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Refer also to citation(s) 6355, 6359, 6361, 6418, 6419, 6434, 6444, 6448, 6459, 6771, 6822, 6892, 6894, 6906, 6907, 6908

6363 (DOE/FTR–93018121) **Travel to New Zealand for symposium on wood and pulping chemistry: Foreign trip report, April 29–May 9, 1991.** Chum, H.L. Solar Energy Research Inst., Golden, CO (United States). 20 Jun 1991. 116p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE93018121. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The purpose of the trip was to assess the state-of-the-art of analytical methods for wood, pulp, lignin, and other biomass materials. Attended the 6th ISWPC which highlighted worldwide developments in wood and biomass chemistry, biotechnology, and biomass utilization. Particular emphasis was on Australia/New Zealand/Japan and surrounding countries, since the meeting was combined with the local pulp and paper association (APPITA) meeting. Attended the Methods of Analyses of Wood and Environmental Samples (MAWES) post-symposium, which was a small meeting, by invitation only, with focus on analytical methodologies. Visited the Forest Research Institute (FRI) including the Pulp and Paper Research Organization (PAPRO). This institution is funded both by the New Zealand government and private industry in forest health, improvement, management, and resources; wood technology (pulp and paper, solid wood products, wood chemistry, and wood utilization); and forest and wildland ecosystems. New Zealand researchers highlight the uniqueness of their Institute, which congregates biomass production, quality, utilization, and integrated management in one organization. Visited the Tasman Forestry Ltd. radiata pine plantation at Tarawera. Attended the local (NZ) chapter meeting of the APPITA, highlighting some of the local and international concerns in natural resources utilization. One oral and two poster papers were presented at the 6th ISWPC and one oral paper was presented at the MAWES meeting. In both cases, the IEA Voluntary Standards of Analyses of Wood and Annual Plants activities were presented, in addition to advances in analytical chemistry of short rotation energy crops.

6364 (DOE/FTR–94004857) **Travel to Spain for the IEA Pyrolysis Working Group meeting: Foreign trip report, November 27–December 4, 1993.** Gregoire, C.E. National Renewable Energy Lab., Golden, CO (United States). 31 Dec 1993. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94004857. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The semi-annual meeting of the IEA Pyrolysis Working Group was held in Santiago de Compostela, Spain, November 30–December 3, 1993. The Pyrolysis Group is actually performing technoeconomic evaluations of biomass gasification and pyrolysis processes. The objectives of the meeting were to evaluate work to date, and to determine the assignments for production of the final report, which is due at the end of 1994. The official meeting minutes are attached as Appendix A. The itinerary is included as Appendix B.

6365 (ETSU-B/B–3/00242/REP) **The sustainable landfill: A feasibility study to assess the potential of developing a bioreactor cell rotation landfill.** Applied Environmental Research Ltd., Colchester (United Kingdom). 1993. 104p. Sponsored by AEA Environment and Energy, Harwell (United Kingdom). Order Number DE94730466. Source: OSTI; NTIS (US Sales Only).

To assess the potential for developing a bioreactor cell rotation landfill, it is necessary to review suitable waste arisings, evaluate appropriate separation methods and estimate the potential gas yields from these materials. This feasibility study uses this information to provide a workable design for the sustainable landfill, assess the compatibility of the system with operational aspects of landfilling and evaluate the economic viability of such a facility. (author)

6366 (ETSU-B/T–1/00207/REP) **An assessment of thermochemical conversion systems for processing biomass and refuse.** Bridgwater, A.V.; Evans, G.D. Aston Univ., Birmingham (United Kingdom); Dk-Teknik, Soeborg (Denmark). 1993. 251p. Sponsored by AEA Environment and Energy, Harwell (United Kingdom). Order Number DE94726335. Source: OSTI; NTIS (US Sales Only).

A survey of gasification, pyrolysis and liquefaction technologies for biomass and waste has been conducted to identify processes suitable for opportunities in the UK and Denmark. Combustion of biomass and waste is omitted as it is considered to be well established technology with a wide variety of systems available for implementation. Of 57 processes identified as being relevant that are currently or recently under development, 22 have been selected for more detailed investigation. (author)

6367 (NREL/CP–200-5768-Vol.1, pp. 393-405) **WBP: The wood Brazilian BIG-GT demonstration project.** Carpentieri, E. (Companhia Hidro Eletrica do Sao Francisco, Recife (Brazil)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Brazil is one of the leading countries in the use of renewable energy. Most of its electricity comes from hydro power, about 200,000 barrels a day of ethanol from sugar cane is used as fuel, around 38% of the pig iron, and 20% of the steel production, uses charcoal as a reducing medium. Located in the tropics, with the sun shining all year round, and with its vast territory, the Country may be regarded as having all the basic conditions to develop a modern Biomass for Electricity industry. The conjunction of those characteristics with, the necessity of developing new energy resources for electricity production in the Northeast of the Country, the results of the studies made by Princeton University, Shell and Chesf, the progress achieved by the BIG-GT (Biomass Integrated

Gasification Gas Turbine) technology in Europe, and the organization of the Global Environment Facility (GEF), provided the unique opportunity for the implementation of a commercial demonstration in Brazil. This paper describes the idea, the scope, the technical challenges, and actual status of development of the WBP, a project which aims to demonstrate the commercial viability of the BIG-GT technology. It also highlights, the project management structure, the role of the GEF, World Bank and of the United Nations Development Program (UNDP), and the participation of the Brazilian Federal Government, through the Ministry of Science and Technology (MCT). Finally it describes the Participants (ELETROBRAS, CVRD, CIENTEC, SHELL, and CHESF), their role in the project, and how the group was formed and operates.

6368 (NREL/CP–200-5768-Vol.1, pp. 470-497) **Thermal and biological gasification.** Overend, R.P. (National Renewable Energy Lab., Golden, CO (United States)); Rivard, C.J. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Gasification is being developed to enable a diverse range of biomass resources to meet modern secondary energy uses, especially in the electrical utility sector. Biological or anaerobic gasification in US landfills has resulted in the installation of almost 500 MW(e) of capacity and represents the largest scale application of gasification technology today. The development of integrated gasification combined cycle generation for coal technologies is being paralleled by bagasse and wood thermal gasification systems in Hawaii and Scandinavia, and will lead to significant deployment in the next decade as the current scale-up activities are commercialized. The advantages of highly reactive biomass over coal in the design of process units are being realized as new thermal gasifiers are being scaled up to produce medium-energy-content gas for conversion to synthetic natural gas and transportation fuels and to hydrogen for use in fuel cells. The advent of high solids anaerobic digestion reactors is leading to commercialization of controlled municipal solid waste biological gasification rather than landfill application. In both thermal and biological gasification, high rate process reactors are a necessary development for economic applications that address waste and residue management and the production and use of new crops for energy. The environmental contribution of biomass in reducing greenhouse gas emission will also be improved.

6369 (NREL/CP–200-5768-Vol.1, pp. 583-594) **Process and design considerations for the anaerobic digestion of municipal solid waste.** Shrivastava, S.R. (Larsen Engineers, Rochester, NY (United States)); Bastuk, B. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Full scale experience exists and justifies implementing anaerobic digestion for pretreatment of high strength industrial waste water and side streams. Anaerobic treatment of sludge and manure have demonstrated cost effective, environmentally sound treatment of these wastes. Recent attention has focused on the potential for anaerobically treating high solids municipal solid wastes to assist in meeting state waste reduction goals and provide a new renewable source of energy. This paper focuses on the fundamental facility design and process protocol considerations necessary for a high solids anaerobic digesting facility. The primary design and equipment considerations are being applied to a 5 to 10 ton per day demonstration anaerobic digestion facility in Bergen, New York.

6370 (NREL/CP–200-5768-Vol.1, pp. 595-607) **Energy supply of food processing plants and breweries from its specific solid wastes.** Behmel, U. (Technische Universitaet Muenchen, Weihenstephan (Germany)); Leupold, G.; Meyer-Pittroff, R. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Disposal of solid wastes in the food processing industry causes problems. Constant utilization as animal food is not guaranteed any longer and costs for disposal will increase. Biogas production is an alternative for disposal of brewery wastes. Recent investigations have reduced retention time for hydrolysis and total retention time. Retention time is directly proportional to fermenter size consequently resulting in drastic cost reductions. Yielded energy can be utilized in the production line so that fossil fuel use can be reduced with reductions in carbon dioxide emissions. However, some problems remain: sumptous technology; highly qualified specialists; need to reduce ammonia to prevent inhibition of biogas production; cost of technology.

6371 (NREL/CP–200-5768-Vol.1, pp. 608-620) **Biogas production from low temperature lagoon digesters treating livestock manure.** Safley, L.M. Jr. (North Carolina State Univ., Raleigh, NC (United States)); Westerman, P.W. National Renewable Energy Lab., Golden, CO (United States). [1993]. Contract TV-84062-V. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Laboratory anaerobic digesters were fed dairy and swine manure at the rates of 0.1 and 0.2 kg volatile solids (VS)/m^3-day over the temperature range of 10–23°C. The digesters were operated successfully with little indication of instability.

6372 (NREL/CP–200-5768-Vol.1, pp. 649-663) **Manufacturing combustible briquettes from forestry and timber industries' wastes in order to reduce the overexploitation of fuelwood in Central American forests.** Ortiz, L. (Renewable Energies Institute, Soria (Spain)); Gonzalez, E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

A serious degradation of Central American forest is currently taking place because of uncontrolled fuelwood overexploitation. As an example, in Guatemala over 40% of forest destruction is caused by this reason. In the meanwhile, waste biomass from the sawmills representing 30 to 50% of total wood volume processed, due to low technological level of the facilities, and having an energetic potential equivalent to their thermal and electric needs is destroyed through uncontrolled burning, thus causing important environmental and landscape impact, since the byproducts are incinerated outdoors on the spot the constant smoke together with the noise level produced by the diesel power generators makes working conditions painful for the large labor force usually operating these sawmills because of low wages in these countries. To help solve this increasing problem, it would be possible to use the waste biomass for the production of electric power, through cogeneration, for sawmill selfuse or selling to the public electric lines, or even manufacturing of fuel briquettes which would have a potential market in countries such as Republica Dominicana, Honduras Guatemala, etc. as a substitute for charcoal and fuelwood, thus permitting a considerable reduction of the environmental degradation and predation suffered by forest areas in these countries. For these reasons, we consider it of interest to study briquetting techniques and their intrinsic problems in depth. For such purpose, we have carried out a series of real scale briquetting experiences with different types of lignocelulosic wastes and mixtures of them under different conditions, aiming to optimize procedure methodology and reduce production expenses, thus making offer increase easier. Manufacturing procedure and analytics developed to carry out the experiences are described in the present document. Main results

obtained are summarized, and mathematical, energetic, analytical and economic aspects are discussed as well.

6373 (NREL/CP–200-5768-Vol.1, pp. 730-735) **Drying wood waste with a pulse combustion dryer.** Buchkowski, A.G. (Spectrum Engineering Corp., Ltd., Peterborough, Ontario (Canada)); Kitchen, J.A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

There is a vast amount of wood waste available to be used as an alternate fuel if its moisture could be reduced efficiently. Tests have been conducted to assess an industrial dryer using pulse combustion as a heating source for drying wood waste; specifically sawdust and pulverized wet hog fuel. Pulse combustion offers the advantage of high heat transfer, efficient combustion, and low NO_x emissions. The material is injected into the exhaust gases in the tailpipe of the combustor which uses natural gas or propane as a fuel. The turbulence created by the pulsations enhance the drying process by reducing the boundary layer thicknesses. The materials is further dried in a rotary drum. The material has been dried without scorching or burning in tests where the inlet moisture content has been as high as 60% on a wet basis. The outlet moisture contents achieved have typically been 10%. Analysis of the test data and cost estimates of the equipment indicate that the pulse combustion drying system is at least comparable to existing systems in terms of operating costs, and offers very significant savings in capital costs. Testing with various other materials such as wood pulp, sludges and peat is continuing to further assess the equipment's performance.

6374 (NREL/CP–200-5768-Vol.1, pp. 747-758) **North Plant co-generation project for South Davis County Sewer Improvement District.** Rogers, L.S. (Aqua Environmental Services, Inc., Bountiful, UT (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

In the summer of 1988, the South Davis County Sewer Improvement District (SDCSID) learned of a grant/loan program being administered by the Utah State Department of Energy(DOE) for projects that demonstrate new and innovative ways of conserving energy or utilizing renewable energy sources. The SDCSID applied for and received from the DOE both a grant and a no-interest loan to finance half of the cost of a co-generation project at the North Wastewater Treatment Plant. This co-generation project utilizes methane gas, a by-product of the anaerobic digestion process, to generate both electricity and heat that is used at the plant. The SDCSID calculated that at the current anaerobic gas production rate, a 140 KW engine generator could be run almost 24 hours a day. Approximately 75% of the current electrical needs at the North Plant are supplied by the 140 KW engine generator. Also, all of the heat necessary to raise the temperature of the incoming sludge to 95°F, and to heat four large buildings is supplied from the heat recovery system of the engine. The system utilizes an induction type generator to supply electricity, which is somewhat simpler to design and less expensive to install than a synchronous type system. An induction system utilizes the Electrical Utility's incoming power to excite the generator to correct the phase so that is can be used by the loads in the plant. In addition, the SDCSID installed a second identical engine generator as a back-up and to peak shave. Plant effluent is used to cool the engines instead of air-cooling through radiators.

6375 (NREL/CP–200-5768-Vol.1, pp. 759-769) **The Acimet® Process: An innovative approach to biogasification of municipal sludge.** Ghosh, S. (Univ. of Utah, Salt Lake City, UT (United States)); Buoy, K. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

This paper reports the results of successful completion of an advanced anaerobic-digestion-process commercialization program supported by the County of DuPage, IL and the State of Illinois Department of Energy and Natural Resources, Springfield, IL. The project entailed anaerobic digestion of municipal sludge by pilot- and full-scale Acimet Process, which replaced an existing high-rate digestion system. The project was conducted at the Woodridge-Greenevalley wastewater treatment plant of DuPage County, IL. The Acimet Process relies on the application of two-phase anaerobic digestion for enhanced methane production and stabilization of municipal sludges, the disposal of which poses intractable problems in many municipal wastewater treatment plants. Unlike conventional anaerobic digestion processes, the Acimet System optimizes the liquefaction- acidification and acetogenic-methanogenic fermentations in separate acid- and methane-phase digesters operated at different hydraulic residence times (HRTs) to maximize feed hydrolysis and acidification, as well as biomethanation of the acidic intermediates. The Acimet System installed at the Woodridge Plant utilizes two mesophilic upflow digesters of novel design exhibiting unusually high product-formation efficiencies achieved without any mechanical mixing of the reactor contents.

6376 (NREL/CP–200-5768-Vol.1, pp. 783-788) **A fluidized bed furnace fired with biomass waste to supply heat for a spray dryer in a plant producing floortiles.** Gulyurtlu, I. (Instituto Nacional de Engenharia e Tecnologia Industrial, Lisboa (Portugal)); Andre, R.; Mendes, J.; Monteiro, A.; Cabrita, I. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

This project has been implemented at a factory producing floortiles for domestic use. The project consists of a fluidized bed combustion system burning coal or wood or a mixture of both to produce hot combustion gases to provide heat for spray drying process. The system was designed by INETI for a maximum output of 8 MW thermal energy and all the engineering calculations were carried out to dimension the furnace to provide this amount of heat. Shallow bed concept was used for complete burning of the biomass particles which contained volatiles up to 75% by weight. The sand bed was used as a flame stabilizer for the combustion of volatiles. The combustion of volatiles in the freeboard was mainly controlled by mixing ashes and other impurities. The combustion temperature had to be maintained in the range 700–800°C to achieve combustion efficiencies of 85% or more. The combustion efficiency (1) did not increase substantially above 90% of excess air although levels of up to 120% were used during combustion and (2) was found to increase through air staging in the order of 20 to 25%, by simply adding 45 to 55% of the air required to the freeboard zone. No SO_2 was observed in flue gases when burning only biomass but there was some NO_x formed and the level of conversion of fuel-N to NO_x was found to be about 25–30%.

6377 (NREL/CP–200-5768-Vol.2, pp. 797-814) **An overview of the current status of biodiesel.** Reed, T.B. (Colorado School of Mines, Golden, CO (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Vegetable oils (and animal fats) have been used as lighting fuels since Egyptian times, but recent testing shows that they are not suitable for diesel engines, causing poor spray and coking. Transesterification of the oils with methanol cleaves the oil/fat molecule into 3 parts and removes the glycerine, yielding a viscosity and other properties comparable to that of diesel. The resulting esters

have been given the generic name "biodiesel." Biodiesel can be made from vegetable oils and animal fats by transesterification with methanol or ethanol using Acid or base catalysts. Only minor variations in characteristics such as Cetane number and pour point occur with various feedstocks. The heat of combustion of biodiesel is 95% of that for conventional diesel (on a volume basis). The viscosity is no more than double that of No. 2 diesel. Biodiesel has a Cetane number of 50–80 (compared to typically 42 for diesel). The Cetane number is important in determining emissions. Biodiesel fuel requires no engine modification for use in conventional diesel engines. The engine characteristics have been widely tested in engines and fleets in the US, Brazil, and in Europe. Reduced emissions (except NOX) are reported for both blends and neat. Vegetable oils cost typically $2–$4/gal, and so require a subsidy to compete economically with diesel today. It is expected that this cost can be reduced with improved species and improved yields. The cost of biodiesel can also be reduced by using waste vegetable cooking oils which typically contain 4-8% free fatty acids that must be removed. Processing costs are estimated to be $0.50 above the feedstock cost, so that $2/gal vegetable oils would give biodiesel at $2.50/gal biodiesel. Biodiesel is certainly the best candidate for an alternate diesel fuel.

6378 (NREL/CP–200-5768-Vol.2, pp. 815-826) **Transesterification process to manufacture ethyl ester of rape oil.** Korus, R.A. (Univ. of Idaho, Moscow, ID (United States)); Hoffman, D.S.; Bam, N.; Peterson, C.L.; Drown, D.C. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

A process for the production of the ethyl ester of winter rape [EEWR] for use as a biodiesel fuel has been studied. The essential part of the process is the transesterification of rape oil with ethanol, in the presence of a catalyst, to yield the ethyl ester of rape oil as a product and glycerin as a by-product. Experiments have been performed to determine the optimum conditions for the preparation of EEWR. The process variables were: (1) temperature, (2) catalyst, (3) rate of agitation, (4) water content of the alcohol used, and (5) the amount of excess alcohol used. The optimum conditions were: (1) room temperature, (2) 0.5% sodium methoxide or 1% potassium hydroxide catalyst by weight of rapeseed oil, (3) extremely vigorous agitation with some splashing during the initial phase of the reaction and agitation was not necessary after the reaction mixture became homogeneous, (4) absolute ethanol was necessary for high conversion, and (5) 50% excess ethanol with $NaOCH_3$ or 100% excess with KOH gave a maximum conversion. Viscosity, cloud point and pour point of the EEWR were measured. A preliminary break-even cost for the commercial production of EEWR was found to be $0.55/liter [$2.08/US gallon].

6379 (NREL/CP–200-5768-Vol.2, pp. 827-836) **Conversion of rice hulls to diesel fuel.** Ochs, S. (Arizona State Univ., Tempe, AZ (United States)); Kuester, J. National Renewable Energy Lab., Golden, CO (United States). [1993]. DOE Contract FC65-93WA09072. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The status of a project to convert rice hulls to the equivalent of No. 2 diesel fuel will be presented. Other byproducts include naptha and waxes. The project participants are Arizona State University (ASU) and Rentech, Inc. of Denver, CO. Arizona State Univ. has developed technology for converting numerous biomass materials to fuels and chemical products. Rentech, Inc. is a leader in converting natural gas from landfill and remote natural gas sites to diesel fuel and other products. The project thus is aimed at coupling the ASU gasification (pyrolysis) technology (biomass to synthesis gas) with Rentech liquefaction technology (synthesis gas to diesel fuel). Rice hulls have been selected as the feedstock due to low value, commercial interest and global availability. The diesel product attractive due to local marketing and environmental (no sulfur) features. Diesel yields in the 40–50 gallons per ton of feedstock (dry, ash free basis) are anticipated. The Statement of Work for the project consists of feedstock source evaluation, pyrolysis experiments, liquefaction experiments, technical evaluation and economic evaluation. Results and conclusions to date will be presented.

6380 (NREL/CP–200-5768-Vol.2, pp. 837-847) **Nonaqueous enzymatic synthesis of ester fuels.** Olson, E.S. (Universal Fuel Development Associates, Inc., Grand Forks, ND (United States)); Singh, H.K.; Yagelowich, M.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. DOE Contract AC02-88ER80614. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The application of nonaqueous enzyme slurries for the production of fatty ester fuels from coal-derived alcohols and triglyceride oils was investigated. Nonaqueous enzyme systems can greatly facilitate many organic reactions, especially those that result in formation of esters and amides. The production of biomass ester fuels from triglyceride oils involves transesterification of the triglyceride with an alcohol. Phenolic tars from coal gasification wastes were fractionated and treated to convert them to an alcohol form, and the intermediate alcohols were converted to the fatty ester in a nonaqueous lipase system. Lipases in a variety of organic solvents were intensively investigated for acylation of coal derivatives containing alcohol functional groups. The two-step process transformed the black poorly soluble phenolics to clean paraffin-soluble esters. Diesel testing demonstrated that the product esters could be substituted for diesel fuels.

6381 (NREL/CP–200-5768-Vol.2, pp. 863-875) **Chemical composition of tall oil-based cetane enhancer for diesel fuels.** Feng, Y. (Arbokem Inc., Vancouver, British Columbia (Canada)); Wong, A.; Monnier, J. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Tall oil is a co-product of the manufacture of kraft softwood pulp. The principal constituents of tall oil are unsaturated C_{18} fatty acids, resin acids and unsaponifiables such as diterpenic alcohols/aldehydes. Tall oil has been shown to be an economical feedstock for the manufacture of cetane enhancer for diesel fuels, using the proprietary CANMET (Canada Centre for Mineral and Energy Technology) technology. Under a joint R&D project between Arbokem Inc./BC Chemicals Ltd. and CANMET, pilot plant tests were conducted recently at the CANMET Energy Research Labs. in Ottawa. The results showed that tall oil could by hydroprocessed efficiently to yield a valuable fuel blending agent. When this product was mixed with conventional diesel fuel, the cetane number of the diesel fuel increased linearly with the addition of the product. Chemical analysis including chromatography-mass spectrometry has confirmed high conversion of tall oil components into straight-chain alkanes. A small amount of cyclic hydrocarbons and sulphur components were present in the tall oil-based diesel enhancer. Preliminary results indicate that this type of cetane enhancer would provide additional technical benefits. The low aromatics content of the tall oil-based cetane enhancer would significantly reduce aromatics in the final diesel fuel blend. Diesel engines operating on such fuel blends would have a lower propensity to form particulates and NO_x.

6382 (NREL/CP–200-5768-Vol.2, pp. 902-909) **Biodiesel from microalgae: Complementarity in a fuel development strategy.** Brown, L.M. (National Renewable Energy Lab., Golden, CO (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment,*

agriculture, and industry: Proceedings, Volume 2. 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Biodiesel produces fewer pollutants than petroleum diesel, and is virtually free of sulfur. These properties make biodiesel an attractive candidate to facilitate compliance with the Clean Air Act Amendments of 1990 (CAAA). This fuel is ordinarily considered to be derived from oilseeds, but an essentially identical biodiesel can be made from microalgae. This technology is complementary to ongoing efforts to grow lignocellulosic biomass in areas with good soil and water resources, because microalgae are projected to be grown in those areas where lignocellulosics or oilseed crops will not grow well (desert southwestern United States and other areas with poor soils). Another area where microalgae are complementary to other energy crops is in quad potential and market readiness. The potential contribution of oilseeds and waste fats to the energy supply is much less than 1 quadBTU/yr (1 EJ/yr). However, oilseed biodiesel can be made available quickly, thus helping to solve local air pollution problems over the short term and establishing an early market niche for biodiesel. Microalgal biodiesel would come on line later after further technology development to fulfill the multi-quad demand for diesel.

6383 (NREL/CP–200-5768-Vol.2, pp. 916-921) **Rapeseed oil as diesel fuel, an overview.** Peterson, C.L. (Univ. of Idaho, Moscow, ID (United States)); Brown, J.; Guerra, D.; Drown, D.C.; Withers, R.V. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

For more than a decade, Idaho researchers have been evaluating the potential of vegetable based fuels as a diesel substitute. The investigations began by using unmodified vegetable oils in diesel engines, then progressed to the use of modified vegetable oil through the transesterification process. The fuel production process was identified, developed, optimized, evaluated and improved. The oilseeds used for the process are from several cultivars of rapeseed developed by Idaho workers and grown locally. At first, the main focus of fuel evaluation was on rapeseed methyl ester (RME), for which off-road engine tests have been done, including: (a) short term tests on a stationary tractor engine; (b) fuel performance tests on small stationary engines; (c) endurance engine tests (1,000 hours duration); (d) durability testing of engines; (e) combustion modeling of the fuel (KIVA) using the Cray supercomputer at Los Alamos National Lab.; and (f) fuel utilization in tractors used in normal farm operations. The engine tests indicate that RME is a suitable substitute for diesel fuel. In recent months, the process of transforming rapeseed oil into a suitable fuel has been upgraded and modified. A simpler and shorter transesterification process has been developed and identified. The process uses ethanol as the other main ingredient. The washing phase has also been redesigned. Ethanol is a "better" alcohol compared to methanol because the former is derived from agricultural products, is a renewable fuel, and is relatively harmless to the environment.

6384 (NREL/CP–200-5768-Vol.2, pp. 922-927) **Rapeseed and safflower oils as diesel fuels.** Peterson, C.L. (Univ. of Idaho, Moscow, ID (United States)); Haines, H.; Chase, C. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

During the past decade the US has become increasingly dependent upon imported oil to meet our energy demands. Nearly 50 percent of our US consumption of petroleum is imported. Research has shown that agricultural crops can be used to reduce this dependence. Vegetable oil as an alternative fuel has been under study at the Univ. of Idaho since 1979. Since then the Idaho research team has pioneered the use of rapeseed oil as a diesel fuel substitute. Idaho's interdisciplinary team includes plant breeding, plant modification, process development and scale-up, engine testing, and economics. Researchers in Montana have studied safflower oil as a potential diesel fuel replacement since 1983. This project, aimed for use of safflower oil in railroad engines, involves genetics, agronomics, economics and contract engine testing.

6385 (NREL/CP–200-5768-Vol.2, pp. 928-930) **Processing waste fats into a fuel oil substitute.** Pudel, F. (OEHMI Forschung und Ingenieurtechnik GmbH, Magdeburg (Germany)); Lengenfeld, P. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Waste fats have a high energy potential. They also contain impurities. For example, fats used for deep-frying contain high contents of solids, water, and chlorides. The process described in this paper removes the impurities by simple processing such as screening, washing, separating, drying, and filtering. The final quality of processed fat allows its use as a fuel oil substitute, and also as a raw material for chemical production.

6386 (NREL/CP–200-5768-Vol.2, pp. 931-946) **Production of fuels by cellulose liquefaction.** Datta, B.K. (Univ. of Manchester Institute of Science and Technology (United Kingdom)); McAuliffe, C.A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The effect of temperature on the liquefaction of cellulose was investigated in a range 200° to 350°C in aqueous medium with 5% pt/Al_2O_3 catalyst, at 35 bars of hydrogen as reducing gas and a reaction time of 2 hours. Experiments were conducted in a 1 liter batch rocker autoclave reactor. The conversion increased from 46.5% at 200°C to 92.46% at 350°C, the oil yield increased from 18% at 200° to 33% at 350°C. At the high temperature, 350°C, the water soluble fraction and char formation decreased due to the conversion of the above to various gases. Moreover, ether solubles in water soluble fractions also decreased while the production of water increased from 8% at 200°C to 29% at 350°C. It suggests the possibility of removal of oxidants from the feedstocks as water. Initial dehydration reactions were obviously responsible for the high yield of water. Water yield increased gradually with the increase in temperature which was probably due to the dehydration of the intermediary products and the concurrent removal of oxygen atom as water instead of as CO or CO_2. At high temperatures, more CO_2 gas was formed due to the water gas shift reaction. The formation of CO_2 is favored over the formation of CO. At high temperatures more hydrocarbon gases were formed. Solvent extraction of the oils showed that the maximum percentage of carboxylic acids and phenolic compounds formed in comparison with carbonyl and neutral compounds when temperature increased.

6387 (NREL/CP–200-5768-Vol.2, pp. 947-963) **Fast pyrolysis of sweet soghum bagasse in a fluidized bed.** Palm, M. (Chalmers Institute of Technology, Gotheborg (Sweden)); Peacocke, C.; Bridgewater, A.V.; Piskorz, J.; Scott, D.S. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Samples of Italian sorghum bagasse were dried and ground and then pyrolyzed in the Waterloo Fast Pyrolysis bench scale reactor unit. Results were typical of agricultural grasses of this kind, and resembled those obtained from similar tests of sugar cane bagasse. A maximum liquid yield (dry feed basis) of 68% by weight of dry feed was achieved, with a corresponding char yield (ash included) of 16%. The high ash content of the bagasse (9.2%) gave

a char with a very high ash content (≈50%), with calcium as the most abundant cation. Yields of hydroxyacetaldehyde were comparable to those obtained from softwoods. Deionized bagasse gave significant yields of anhydrosugars on pyrolysis. Sorghum bagasse appears to be a suitable feedstock, either for pyrolysis to yield an alternative fuel oil, or after pretreatment and pyrolysis, to yield a solution of fermentable sugars.

6388 (NREL/CP–200-5768-Vol.2, pp. 1032-1044) **Waste paper and pulp sludge as feedstock for ethanol production.** Sosulski, K. (Saskatchewan Research Council, Saskatoon (Canada)); Swerhone, B. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Samples of newsprint, office, cardboard and magazine paper, paper towels, pulp waste and sludge were evaluated for their cellulose contents and rates of cellulose conversion to glucose. Several pretreatments were evaluated to increase the rate of conversion of newsprint cellulose to glucose. The influence of printers' inks on enzyme hydrolysis and fermentation were determined for printed newsprint and magazine paper and corresponding imprinted controls. Two streams of mixed paper were formed to determine the need for separation of paper prior to processing. A modified, two-stage process was evaluated for hydrolyses of paper samples. The process consisted of sample hydrolysis with one-half of total enzymes for 24 hr, separation of sugars by filtration and hydrolysis of the residue with fresh enzymes for an additional 24 hr. In this way, at the same enzyme loading, the rates of cellulose conversion were increased by 18 to 59%, depending on sample. The maximum cellulose conversion rates were: 62.4% for newsprint, 65.4% for cardboard, 65.7% for office paper, 54.5% for magazine paper and 55.0% for paper towel. Bleached pulp waste was hydrolysed to the level of 62.7%, and the rates of conversion of pulp sludge cellulose were 32.4 to 74.6%, depending on paper waste used for reprocessing by pulp mills. The degrees of saccharification determined for the mixed paper samples were comparable or slightly lower than those calculated based on the best conversion rates for each of the constituents and their contents in mixed sample. Based on the findings of this study, it became apparent that ethanol plants would be able to process all types of paper and pulp wastes blends, at varying ratios, without the need for separation of waste streams. Also, there was no need for other pretreatments than particle size reduction by grinding, prior to enzyme hydrolysis. Printers' inks had no adverse affect on enzyme hydrolysis or yeast fermentation.

6389 (NREL/CP–200-5768-Vol.2, pp. 1045-1055) **Production of ethanol from corn fiber.** Elander, R.T. (National Renewable Energy Lab., Golden, CO (United States)); Russo, L.J. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

In the corn dry-milling process, ethanol is produced from the starch-based carbohydrate fraction of the corn kernel. The remaining carbohydrate fiber – which includes cellulose, hemicellulose, and unconverted starch, along with protein, fats, and oils – is recovered, dried, and sold as an animal feed supplement known as distillers dried grains and solubles (DDGS). Since the value of any animal feed supplement is directly based on its protein content, it is possible to remove the fiber fraction without diminishing the value of this co-product. A Cooperative Research and Development Agreement between the National Renewable Energy Laboratory and the New Energy Company of Indiana has been investigating process alternatives for incorporating the conversion of corn fiber to ethanol into an existing dry-milling production facility. In corn, about 13% of the potential ethanol from the carbohydrate fraction originates from cellulose, hemicellulose, and sugars significant amounts of starch-based components that are unconverted in the dry-milling process. Process additions based on simultaneous saccharification and fermentation and hemicellulose conversion technologies can significantly improve the yield and economics of ethanol production from corn by converting these carbohydrate-based components that typically become a zero-value constituent of DDGS in dry-milling processes.

6390 (NREL/CP–200-5768-Vol.2, pp. 1056-1067) **Development of yeasts for xylose fermentation.** Jeffries, T.W. (Univ. of Wisconsin, Madison, WI (United States)); Yang, V.; Marks, J.; Amartey, S.; Kenealy, W.R.; Cho, J.Y.; Dahn, K.; Davis, B.P. National Renewable Energy Lab., Golden, CO (United States). [1993]. Grant 91-019-24. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Xylose is an abundant sugar in hardwoods and agricultural residues. Its use is essential for any economical conversion of lignocellulose to ethanol. Only a few yeasts ferment xylose effectively. Our results show that the best strains are Candida shehatae ATCC 2984 and Pichia stipitis CBS 6054. Wild type strains of C. shehatae ATCC 22984 will produce 56 g/L of ethanol from xylose within 48 h in a fed batch fermentation. We have obtained improved mutants of P.stipitis by selecting for growth on L-xylose and L-arabinose. Mutant strains produce up to 55% more ethanol than the parent and exhibit higher specific fermentation rates. We have also developed an effective transformation system that enables the introduction and expression of heterologous DNA on integrating and autonomous vectors. The transformation system for P. stipitis is based on its URA3 gene as a selectable marker and an autonomous replication sequence (ARS) which we isolated from the parent. We are using integrating and ARS vectors to metabolically engineer P. stipitis by altering the regulation and expression of key enzymes. As model systems we are examining the expression of alcohol dehydrogenase (ADH) and pyruvate decarboxylase (PDC) that are present in limiting amounts or induced only under non-growth conditions.

6391 (NREL/CP–200-5768-Vol.2, pp. 1068-1077) **Improving ethanol production by membrane technology: The continuous saccharification reactor.** Cheryan, M. (Univ. of Illinois, Urbana, IL (United States)); Escobar, J. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The saccharification of liquefied starch is typically done in a batch mode, taking 30–72 hours and requiring large quantities of enzyme (since each dose of enzyme is used only once). The process can be improved considerably by using a membrane reactor in which the reaction vessel is connected in a semi-closed loop configuration to a membrane module of the appropriate chemical nature and physical configuration. The continuous membrane reactor (CMR) concept was first evaluated with a dead-end cell, and later scaled-up to a cross-flow recycle configuration using hollow fibers or spiral wound modules. The CMR results in a dramatic reduction in reaction time to 5–10 hours, and reduces overall enzyme usage by 50–70%. In addition, the dextrose stream is crystal clear with little or no suspended particles, protein or fat, thus potentially reducing downstream costs. The CMR has been scaled up to a pilot-scale system of 1,500 liters with a membrane capacity of 30–65 cm^2, which is presently undergoing on-site trials at a large ethanol plant. The economics of this operation appear to be quite attractive.

6392 (NREL/CP–200-5768-Vol.2, pp. 1078-1090) **Separation of acid and sugar by Ion exclusion chromatography. An application in the conversion of cellulose to ethanol.** Hartfield, S. (Univ. of Southern Mississippi, Hattiesburg, MS (United States)); Hester, R. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First*

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The production of fuel grade alcohol by fermentation from sugars obtained by the acid hydrolysis of cellulose has been hindered by costly methods of cleansing the acid in the sugar stream. An economical and environmentally acceptable acid-sugar separation process based on ion exclusion chromatography has been developed and analyzed. This process recovers the acid for reuse in hydrolysis without producing landfill waste allowing a concentrated acid hydrolysis process to be commercially feasible.

6393 (NREL/CP–200-5768-Vol.2, pp. 1091-1103) **Automated small-scale fuel alcohol plant: A means to add value to food processing waste.** Wolfram, J.H. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Keller, J.; Wernimont, L.P. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

A small scale fuel grade alcohol plant was designed, constructed and operated a decade ago. This plant design incorporated several innovative processes and features that are still on the cutting edge for small scale alcohol production. The plant design could be scaled down or up to match the needs of food processing waste streams that contain sugars or starches as BOD. The novel features include automation requiring four hours of labor per 24 hour day and a plug flow low temperature cooking system which solubilizes and liquifies the starch in one step. This plant consistently produced high yield of alcohol. Yields of 2.6 gallons of absolute alcohol were produced from a bushel of corn. Potato waste grain dust and cheese whey were also processed in this plant as well as barley. Production energy for a 190 proof gallon was approximately 32,000 BTU. This paper discusses the design, results, and applicability of this plant to food processing industries.

6394 (NREL/CP–200-5768-Vol.2, pp. 1104-1109) **Engineering aspects of lignocellulosic biomass conversion to ethanol.** Philippidis, G.P. (National Renewable Energy Lab., Golden, CO (United States)); Smith, T.K. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The cellulosic fraction of biomass can be converted to ethanol, a promising alternative renewable fuel, using the simultaneous saccharification and fermentation (SSF) process. The SSF integrates the enzymatic hydrolysis of cellulose to glucose with the fermentation of glucose to ethanol. Ethanol productivity and yield depend on the characteristics of the biomass, the quality of the cellulase enzyme complex, and the behavior of the fermentative organism. The effects of key engineering factors on SSF performance were studied using real biomass substrate and realistic process conditions. The experimental results indicate that corn steep liquor can replace expensive lab media for the SSF. Saccharomyces cerevisiae D_5A outperforms other leading organisms in terms of both high ethanol productivity and minimal by-product formation. Using that organism, the SSF operational conditions (pH and temperature) were varied in order to optimize the synergism between the cellulase enzyme complex and the fermentative yeast. The SSF performance was optimal at 40°C and initial pH of 4.0–5.0. Higher temperatures resulted in a significant decrease in cell viability and productivity.

6395 (NREL/CP–200-5768-Vol.2, pp. 1110-1115) **Overview of chemical pretreatment of biomass for ethanol production – constraints, challenges, current status, and future trends.** Hsu, T.A. (National Renewable Energy Lab., Golden, CO (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Among the three categories of available pretreatment techniques (i.e., physical, chemical, and biological pretreatment) that prepare biomass for the subsequent bioconversion to ethanol, chemical pretreatment has received the most attention. In chemical pretreatment, the mode of action can be either to swell the biomass matrix or to remove hemicellulose or lignin. It is important to convert both cellulose and hemicellulose fractions into ethanol. With a typical biomass composition (46.2 wt % cellulose, 24.0 wt % xylan, and 24.0 wt % lignin), the maximum theoretical yield is calculated to be 0.13 gal (0.51 L) ethanol/kg dry biomass. For a plant producing 58.5 million gal/y (220 million L/y) ethanol with $42/ton ($46/tonne) dry biomass, assuming the maximum theoretical yield, the break-even ethanol production processing cost is approximately $110/dry ton ($130/dry tonne). Assuming no more than 30% of the processing cost should be allocated for pretreatment, the maximum pretreatment processing cost is in the neighborhood of $35/ton ($40/tonne) dry biomass. This constitutes an engineering constraint to the pretreatment process.

6396 (NREL/CP–200-5768-Vol.2, pp. 1133-1147) **Hot-gas conditioning of biomass derived synthesis gas.** Paisley, M.A. (Battelle, Columbus, OH (United States)); Litt, R.D. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Battelle has tested selected catalysts to evaluate the potential for hot-gas conditioning of biomass gasifier product gas to modify the product gas to produce a gas suitable for methanol synthesis. The Battelle Process Research Unit (PRU) gasifier was utilized as a source of a stable supply of product gas that contained all of the trace constituents that might be present in a commercial scale gasification system. One goal of alternate fuel generation with renewable biomass fuels is the production of a liquid transportation fuel such as methanol. The hot-gas conditioning tests run were planned to evaluate commercial catalysts that would crack hydrocarbons and provide water gas shift activity to adjust the product gas composition for methanol synthesis. During the test program, a novel, low cost catalyst, was identified that showed high levels of activity and stability. The composition of this catalyst is such that it has the potential to be a disposable catalyst and is free from hazardous materials. The initial tests with this catalyst showed high levels of water gas shift activity superior to, and hydrocarbon cracking activity nearly as high as, a commercial cracking catalyst tested.

6397 (NREL/CP–200-5768-Vol.2, pp. 1148-1158) **The production of non hydrocarbon-derived methanol, ethanol and their butyl ethers from biomass and butanes using the MOP process.** Anderson, N.E. (Kilborn Inc., Toronto, Ontario (Canada)); Hallberg, D.E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The proprietary MOP (Multiple Oxygenates Production) Process, covered by US Patent #5,070,016 which was granted in December 1991, offers an unique approach to the production of ethanol, methanol and their t-butyl ethers within the same operating facility. The MOP Process uses fully commercialized process operations to convert grain (or other biomass) and butanes to ethanol, methanol and their ether derivatives in a fully integrated complex, either as a standalone, grass roots project or integrated with an existing ethanol fermentation facility, petroleum refinery or petrochemical complex. Key to the MOP Process is the production of non hydrocarbon-derived methanol from carbon dioxide that is normally

vented from the ethanol fermentation process plus by-product hydrogen from the butane dehydrogenation process (or other external source). In most cases, the methanol is produced entirely from the offgas streams rather than from natural gas, the preferred raw material for the production of most conventional methanol. The integrated MOP Process is highly flexible, especially in terms of its finished product slate, and offers significant cost advantages for the production of MtBE and EtBE from the basic grain and butane raw materials, compared to conventional ether production methods which typically rely on purchased alcohol raw materials. Overall cost advantages for the production of methanol from biomass-derived carbon dioxide and by-product hydrogen are 42–48 cents/USgal, or 14–16 cents/USgal of MtBE equivalent.

6398 (NREL/CP–200-5768-Vol.2, pp. 1194-1200) **The development of commercial scale Rapid Thermal Processing of biomass.** Smith, S.L. (Ensyn Technologies Inc., Gloucester, Ontario (Canada)); Graham, R.G.; Freel, B. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Rapid Thermal Processing (RTP) is a generic technology which employs proprietary reactor configurations to convert carbonaceous feedstocks to high yields of chemical and liquor fuel products. The essential feature is the ability to rapidly transfer heat with precise control of short contact times. The process consists of thermal or thermocatalytic refining of biomass, and is somewhat analogous to the refining of petroleum materials. Nevertheless, the chemical and fuel products are unique and not similar to petroleum-derived products. Furthermore, RTP is not to be confused with conventional pyrolysis, from which it differs fundamentally with respect to product yield and quality, and process conditions and chemistry. Short-term applications include the production of specialty chemicals, fuel oil substitutes and engine fuels for both diesel and turbine engine applications. Research in support of these applications is in progress and is briefly reviewed. The paper focuses primarily on the status of RTP hardware, including the operation of a 1.5 tonne/day pilot plant, and a 25 tonne/day commercial plant.

6399 (NREL/CP–200-5768-Vol.2, pp. 1215-1232) **Catalytic conversion of a wood-derived oil to fuels and chemicals: Effect of process conditions and catalysts.** Adjaye, J.D. (Univ. of Saskatchewan, Saskatoon (Canada)); Bakhshi, N.N. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The effect of run-time, temperature and catalyst regeneration on the upgrading of a bio-oil produced by the high pressure liquefaction of aspen poplar wood were studied in the presence and absence of steam. The bio-oil was processed with HZSM-5 catalyst in a 12.7 mm ID fixed bed micro-reactor at 3.6 WHSV, 1 atm and a temperature range of 290–410°C. The products, which included coke, residue, aqueous fraction, gas and organic distillate were strong functions of the reaction temperature and process time. The objective was to optimize the amount of organic distillate and yield of hydrocarbons, and to minimize coke formation. Without steam, the amount of the organic distillate was maximum 59 wt % at 390°C and contained 65 wt % aromatic hydrocarbons. Alkylated benzenes within the gasoline boiling point range and a number of phenols were the major constituents. With steam, 3–18 wt % increase in organic distillate and 30–45 wt % reduction in coke were obtained. Also, processing only the volatile portion of the bio-oil yielded an even higher hydrocarbon-rich organic distillate. The spent catalyst was easily regenerated and reused four times with little change in its performance. Upgrading studies were also carried out with silicalite, H-mordenite, H-Y and silica-alumina catalysts. The effect of temperature on the organic distillate and hydrocarbon yields were studied. The hydrocarbon yields increased with temperature and were up to 22.1 wt % for silicalite, 27.5 wt % for H-mordenite, 21.0 wt % for H-Y, and 26.2 wt % for silica-alumina at 410°C. The nature and distribution of hydrocarbons depended on the catalyst pore size, acidity and shape selectivity. To understand the reactions involved in upgrading the bio-oil, model compound studies were carried out. A reaction pathway based on these studies is presented.

6400 (NREL/CP–200-5768-Vol.2, pp. 1233-1248) **A novel multi-phase bioreactor for fermentations to produce organic acids from dairy wastes.** Yang, S.T. (Ohio State Univ., Columbus, OH (United States)); Zhu, H.; Li, Y.; Silva, E.M. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

A novel, fibrous bed bioreactor is developed for multi-phase fermentation processes. The microbial cells are immobilized in a spiral-wound, fibrous matrix packed in the bioreactor. This innovative, structured packing design allows good contact between two different moving phases (e.g., gas-liquid or liquid-solid) and has many advantages over conventional immobilized cell bioreactors. Because the reactor bed is not completely filled with the solid matrix, the bioreactor can be operated for a long period without developing problems such as clogging and high pressure drop usually associated with conventional packed bed and membrane bioreactors. This novel bioreactor was studied for its use in several organic acid fermentations. Production of propionate, acetate, and lactate from whey permeate was studied. In all cases studied, use of the fibrous bioreactor resulted in superior reactor performance-indicated by a more than tenfold increase in productivity, reduction or elimination of the requirement for nutrient supplementation to whey permeate, and resistance to contamination-as compared to conventional batch fermentation processes. Also, the reactor maintained high productivity throughout long-term continuous operation. No contamination, degeneration, or clogging problems were experienced during a 10-month period of continuous operation. This new bioreactor is thus suitable for industrial uses to improve fermentation processes which currently use conventional bioreactors.

6401 (NREL/CP–200-5768-Vol.2, pp. 1249-1258) **Three immobilized-cell columnar bioreactors for enhanced production of commodity chemicals.** Davison, B.H. (Oak Ridge National Lab., TN (United States)); Scott, C.D.; Kaufman, E.N. National Renewable Energy Lab., Golden, CO (United States). [1993]. DOE Contract AC05-84OR21400. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Immobilized-cell fluidized-bed bioreactors (FBRs) can be used with a variety of fermentations to increase production of fuels, solvents, organic acids, and other fermentation products. Part of the increased rates and yields are due to the immobilization of the biocatalyst at high concentrations. This FBR system with immobilized Zymomonas mobilis increased ethanol productivity more than tenfold with 99% conversion and near stoichiometric yields. FBRs also offer several additional modes of operation for simultaneous fermentation and separation to further increase production by removing the inhibitory products directly from the continuous fermentation. The production of lactic acid by immobilized Lactobacillus was augmented with the addition and removal of solid adsorbent particles to the FBR. An immiscible organic extractant also was used to extract butanol from the acetone-butanol fermentation by Clostridium acetobutylicum. Demonstrations with these FBR systems have already shown definite advantages by improved overall product yields (decreasing feed costs) and by increased rates (decreasing capital and operating costs). Further demonstration and scale-up continue.

6402 (NREL/CP–200-5768-Vol.2, pp. 1367-1384) **Ablative fast pyrolysis: Converting wood, agricultural wastes and crops into energy and chemicals.** Johnson, D.A. (Interchem Environmental, Inc., Overland Park, KS (United States)); Maclean, D.; Chum, H.L.; Overend, R.P. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Each year more than 170 million tonnes (190 million tons) of yard waste, pallets, forest and agricultural residues are discarded that could become feedstocks for saleable products. The United Stated could potentially grow more than 450 million tonnes (500 million tons) per year of energy crops as dedicated feedstocks in an economically and environmentally sustainable way. About 85% of this lignocellulosic material can be converted into a biocrude oil and charcoal via fast pyrolysis. An engineering scale pyrolysis system has been designed and is being built according to the NREL ablative vortex fast pyrolysis concept in Kansas City. The system has been designed for a throughput of 32.7 dry tonnes (36 dry tons) per day (TPD) of biomass. The 13 mm (1/2 in.) particles enter the vortex reactor where the solid biomass is heated very quickly and is converted into oil vapors, gas, char and water. The char particles are separated from the hot gas and vapor stream. Next, the vapors are condensed to form an oil that is removed for sale or for upgraded products. The residual non-condensible gases are then sent back to the furnace where they are burned to provide process heat. The 36 TPD unit is projected to cost $1.5 million to build. This scale is appropriate for waste feedstocks that are available with a tipping fee in selected locations in the United States. Larger scale units of 90 tonnes (100 tons) and 227 tonnes (250 tons) per day are being designed to gain economies of scale in larger operations. The environmental impacts of a properly designed fast pyrolysis system are minimal and continue to be monitored at all these scales. Fast pyrolysis offers an excellent process for converting biomass into oils, char, and chemicals, much like a petroleum refinery does for crude oil.

6403 (NREL/CP–200-5768-Vol.2, pp. 1441-1447) **Chemicals from biomass by fermentation.** Hinman, R.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The status of fermentation processing is reviewed in terms of the various types of products-antibiotics, commodity chemicals, and genetically engineered proteins. The contribution of biomass to the manufacture of these products is addressed in terms of technical requirements, cost, and environmental considerations.

0910 Properties and Composition

Refer also to citation(s) 6424

6404 (NREL/CP–200-5768-Vol.1, pp. 498-512) **Pilot scale testing of biomass feedstocks for use in gasification/gas turbine based power generation systems.** Najewicz, D.J. (General Electric Corporate Research and Development Center, Schenectady, NY (United States)); Furman, A.H. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

A biomass gasification pilot program was performed at the GE Corporate Research and Development Center using two types of biomass feedstock. The object of the testing was to determine the properties of biomass product gas and its' suitability as a fuel for gas turbine based power generation cycles. The test program was sponsored by the State of Vermont, the US Environmental Protection Agency, the US Department of Energy and Winrock International/US Agency for International Development. Gasification of bagasse and wood chip feedstock was performed at a feed rate of approximately one ton per hour, using the Ge pressurized fixed bed gasifier and a single stage of cyclone particulate removal, operating at a temperature of 1,000 F. Both biomass feedstocks were found to gasify easily, and gasification capacity was limited by volumetric capacity of the fuel feed equipment. The biomass product gas was analyzed for chemical composition, particulate loading, fuel bound nitrogen levels, sulfur and alkali metal content. The results of the testing indicated the combustion characteristics of the biomass product gas are compatible with gas turbine combustor requirements. However, the particulate removal performance of the pilot facility single stage cyclone was found to be inadequate to meet turbine particulate contamination specifications. In addition, alkali metals found in biomass based fuels, which are known to cause corrosion of high temperature gas turbine components, were found to exceed allowable levels in the fuel gas. These alkali metal compounds are found in the particulate matter (at 1000 F) carried over from the gasifier, thus improved particulate removal technology, designed specifically for biomass particulate characteristics could meet the turbine requirements for both particulate and alkali loading. The paper will present the results of the biomass gasification testing and discuss the development needs in the area of gas clean-up and turbine combustion.

6405 (NREL/CP–200-5768-Vol.1, pp. 571-582) **Biomass gasification hot gas cleanup for power generation.** Wiant, B.C. (Westinghouse Electric Corp., Orlando, FL (United States)); Bachovchin, D.M.; Carty, R.H.; Onischak, M.; Horazak, D.A.; Ruel, R.H. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

In support of the US Department of Energy's Biomass Power Program, a Westinghouse Electric led team consisting of the Institute of Gas Technology (IGT), Gilbert/Commonwealth (G/C), and the Pacific International Center for High Technology Research (PICHTR), is conducting a 30 month research and development program. The program will provide validation of hot gas cleanup technology with a pressurized fluidized bed, air-blown, biomass gasifier for operation of a gas turbine. This paper discusses the gasification and hot gas cleanup processes, scope of work and approach, and the program's status.

6406 (NREL/CP–200-5768-Vol.1, pp. 718-723) **Direct observation of the release of alkali vapor species in biofuel combustion and gasification.** French, R.J. (National Renewable Energy Lab., Golden, CO (United States)); Milne, T.A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The largest present use of biomass for energy is in combustion for steam and electrical power. Biofuels have an acknowledged advantage over coal as a solid fuel because of their low sulfur and ash content. However, some forms of biomass have substantial quantities of alkali metals and chlorine. In addition, evidence indicates that the alkali in biomass is largely atomically dispersed, resulting in its facile mobilization into the gas-phase. Gaseous alkali compounds aggravate problems of slagging, fouling, and corrosion on heat transfer surfaces in present-day boilers. These problems can be particularly severe when mixed and variable agricultural residues are burned. Furthermore, the next generation of biomass-to-power systems will likely involve combined cycle gas turbines, where alkali tolerances are especially restrictive. In this

paper, we report on laboratory studies in which biofuels are combusted under simulated turbine or boiler-firing conditions. Gaseous alkali, sulfur, nitrogen, and halogen-containing species are measured by direct extraction from the hot gases through molecular-beam mass spectrometry (MBMS). The experimental apparatus will be described and its capability illustrated with results of time-resolved evolution of species like K, KCl, KOH, SO_2 and NO_x from small samples of biomass in combustion environments. The nature and release of such species will be explicated by referring to thermodynamic equilibrium predictions and the form of alkali in solid, gaseous, and liquid biofuels.

0920 Combustion

Refer also to citation(s) 6342, 6374, 6405, 6434, 6447

6407 (NEI-DK–1388) **Investigation of straw handling and feeding equipment.** Koch, T. Koch (T.) Energi, Vanloese (Denmark). Oct 1993. 72p. (In Danish). Contract ENS-51161-93.0004. Order Number DE94730336. Source: OSTI; NTIS.

Cover title: Undersoegelse af halmhaandterings- og indfoednings udstyr.

A study of commercially available pretreatment and feeding equipment for straw fuel was performed. It was found that biomass dividing devices comprise a great fire risk. Fast revolving cutters consume 100-500 kJ pr. kg biomass, and are sensitive to moisture. The energy consumption of slow revolving cutters is between 20 and 60 kJ pr kg of biomass suited for screw transport. Balebreakers use less energy, but are sensitive to moisture, and foreign bodies, especially rotating ones (energy consumption = 10-30 kJ per kg biomass). Reciprocating balebreakers have a tendency to pull out slices of the bale and so stopping flow. Screw conveyers are cheaper and can be made airtight and robust. Energy consumption is higher. For densification of biomass, pill and briquette presses can be used, but it can be expensive and energy requirements are very high. The crankshaft rampress is very sensitive to varying conditions in the biomass. Screwfeeders are designed to feed into combustion chambers with a pressure very close to atmospheric pressure. Pistonfeeders for small boilers are made to feed only small bales. (AB) (28 refs.)

6408 (NREL/CP–200-5768-Vol.1, pp. 347-367) **Biomass combustion technologies for power generation.** Wiltsee, G.A. Jr. (Appel Consultants, Inc., Stevenson Ranch, CA (United States)); McGowin, C.R.; Hughes, E.E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Technology in power production from biomass has been advancing rapidly. Industry has responded to government incentives such as the PURPA legislation in the US and has recognized that there are environmental advantages to using waste biomass as fuel. During the 1980s many new biomass power plants were built. The relatively mature stoker boiler technology was improved by the introduction of water-cooled grates, staged combustion air, larger boiler sizes up to 60 MW, higher steam conditions, and advanced sootblowing systems. Circulating fluidized-bed (CFB) technology achieved full commercial status, and now is the leading process for most utility-scale power applications, with more complete combustion, lower emissions, and better fuel flexibility than stoker technology. Bubbling fluidized-bed (BFB) technology has an important market niche as the best process for difficult fuels such as agricultural wastes, typically in smaller plants. Other biomass power generation technologies are being developed for possible commercial introduction in the 1990s. Key components of Whole Tree Energy™ technology have been tested, conceptual design studies have been completed with favorable results, and plans are being made for the first integrated process demonstration. Fluidized-bed gasification processes have advanced from pilot to demonstration status, and the world's first integrated wood gasification/combined cycle utility power plant is starting operation in Sweden in early 1993. Several European vendors offer biomass gasification processes commercially. US electric utilities are evaluating the cofiring of biomass with fossil fuels in both existing and new plants. Retrofitting existing coal-fired plants gives better overall cost and performance results than any biomass technologies;but retrofit cofiring is "fuel-switching" that provides no new capacity and is attractive only with economic incentives.

6409 (NREL/CP–200-5768-Vol.1, pp. 368-381) **Cofiring of biofuels in coal fired boilers: Results of case study analysis.** Tillman, D.A. (Ebasco Environmental, Sacramento, CA (United States)); Hughes, E.; Gold, B.A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Ebasco Environmental and Reaction Engineering, under contract to EPRI, performed a case study analysis of cofiring biomass in coal-fired boilers of the Tennessee Valley Authority (TVA). The study was also sponsored by DOE. This analysis included evaluating wood fuel receiving, preparation, and combustion in pulverized coal (PC) boilers and cyclone furnaces and an assessment of converting wood into pyrolysis oil or low Btu gas for use in a new combined cycle combustion turbine (CCCT) installation. Cofiring wood in existing coal-fired boilers has the most immediate potential for increasing the utilization of biofuels in electricity generation. Cofiring biofuels with coal can potentially generate significant benefits for utilities including: (1) reducing emissions of SO_2 and NO_x; (2) reducing the net emissions of CO_2; (3) potentially reducing the fuel cost to the utility depending upon local conditions and considering biomass is potentially exempt from the proposed Btu tax and may get a 1.5 cent/kWh credit for energy generated by wood combustion; (4) supporting local industrial forest industry; and (5) providing a long term market for the development of a biofuel supply and delivery industry. Potential benefits are reviewed in the context of cofiring biofuel at a rate of 15% heat input to the boiler, and compares this cofiring strategy and others previously tested or developed by other utilities. Other issues discussed include: (1) wood fuel specifications as a function of firing method; (2) wood fuel receiving and preparation system requirements; (3) combustion system requirements for cofiring biofuels with coal; (4) combustion impacts of firing biofuels with coal; (5) system engineering issues; (6) the economics of cofiring biofuel with coal. The Allen, TN 330 MW(e) cyclone boiler and Kingston, TN 135 MW(e) Boiler #1, a tangentially fired PC unit, case studies are then summarized in the paper, highlighting the cofiring opportunities.

6410 (NREL/CP–200-5768-Vol.1, pp. 382-392) **Successful experience with limestone and other sorbents for combustion of biomass in fluid bed power boilers.** Coe, D.R. (LG&E Power Systems, Inc., Irvine, CA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

This paper presents the theoretical and practical advantages of utilizing limestone and other sorbents during the combustion of various biomass fuels for the reduction of corrosion and erosion of boiler fireside tubing and refractory. Successful experiences using a small amount of limestone, dolomite, kaolin, or custom blends of aluminum and magnesium compounds in fluid bed boilers fired with biomass fuels will be discussed. Electric power boiler firing experience includes bubbling bed boilers as well as circulating fluid bed boilers in commercial service on biomass fuels. Forest sources of biomass fuels fired include wood chips, brush chips, sawmill waste wood, bark, and hog fuel. Agricultural sources of biomass fuels fired include grape vine prunings, bean straw, almond tree chips, walnut tree chips, and a variety of other agricultural waste fuels. Additionally, some urban sources of wood fuels have been commercially burned with the addition of limestone. Data presented includes qualitative and quantitative analyses of fuel, sorbent, and ash.

6411 (NREL/CP–200-5768-Vol.1, pp. 406-421) **Alkali slagging problems with biomass fuels.** Miles, T.R.; Miles, T.R. Jr.; Baxter, L.L.; Jenkins, B.M.; Oden, L.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Biomass fueled power boilers are unable to burn more than minor percentages of annually generated agricultural fuels. Determining the mechanisms of deposit formation, and developing means of increasing the proportion of these annual biofuels to be fired are the aims of the ongoing Alkali Deposit Investigation sponsored by DOE/NREL with matching funds from industry sponsors, combining Science, Engineering and Industry.

6412 (NREL/CP–200-5768-Vol.1, pp. 422-439) **On-site power generation for the future.** McCarroll, R.L. (Power Generating, Inc., Fort Worth, TX (United States)); Partanen, W.E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Power Generating, Inc. is developing a direct-fired gas turbine power system designed to operate on solid fuel. This presentation will summarize the results of the development work performed to date and will outline the program currently underway to demonstrate the technical and economic viability of a gas turbine fired on white wood and subsequently on coal. The presentation will describe testing already completed on a pressurized cyclonic burner which forms the external combustion stage for the solid fuel fired gas turbine and the testing that has been done on various fuels categorized as acceptable "fuels of choice" for the demonstration project. Also to be covered will be a discussion of the equipment to be used in the demonstration project, the reasons why specific pieces of equipment have been selected, and how they might be modified for the gas turbine application.

6413 (NREL/CP–200-5768-Vol.1, pp. 454-460) **Computational model of a whole tree combustor.** Bryden, K.M. (Univ. of Wisconsin, Madison, WI (United States)); Ragland, K.W. National Renewable Energy Lab., Golden, CO (United States). [1993]. Grant RP3407-07. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

A preliminary computational model has been developed for the whole tree combustor and compared to test results. In the simulation model presented hardwood logs, 15 cm in diameter are burned in a 4 m deep fuel bed. Solid and gas temperature, solid and gas velocity, CO, CO_2, H_2O, HC and O_2 profiles are calculated. This deep, fixed bed combustor obtains high energy release rates per unit area due to the high inlet air velocity and extended reaction zone. The lowest portion of the overall bed is an oxidizing region and the remainder of the bed acts as a gasification and drying region. The overfire air region completes the combustion. Approximately 40% of the energy is released in the lower oxidizing region. The wood consumption rate obtained from the computational model is 4,110 kg/m^2-hr which matches well the consumption rate of 3,770 kg/m^2-hr observed during the peak test period of the Aurora, MN test. The predicted heat release rate is 16 MW/m^2 (5.0*10^6 Btu/hr-ft^2).

6414 (NREL/CP–200-5768-Vol.1, pp. 467-469) **Steam generation by combustion of processed waste fats.** Pudel, F. (OEHMI Forschung und Ingenieurtechnik GmbH, Magdeburg (Germany)); Lengenfeld, P. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The use of specially processed waste fats as a fuel oil substitute offers, at attractive costs, an environmentally friendly alternative to conventional disposal like refuse incineration or deposition. For that purpose the processed fat is mixed with EL fuel oil and burned in a standard steam generation plant equipped with special accessories. The measured emission values of the combustion processes are very low.

6415 (NREL/CP–200-5768-Vol.1, pp. 513-520) **Production of 800 kW of electrical power using medium calorific gas from a biomass gasifier integrated in a combined cycle.** Gulyurtlu, I. (Instituto Nacional de Engenharia e Tecnologia Industrial, Lisboa (Portugal)); Cabrita, I. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

An allothermal fluidized bed biomass gasifier is under construction to operate at a pressure slightly above atmospheric to produce a gaseous fuel of medium heating value. The output of the gasifier is 2.5 x 10^6 kcal/h and will be attached to a gas turbine that is specifically modified to burn the gas produced. The amount of electricity to be generated will be 800 kW. The gasifying medium used is superheated steam at 2.5 bars and 400°C and the amount needed will be 280 kg/h. The gasifier will have a cross sectional area of 2.1 m^2 with dimensions of 1 500 mm x 1 400 mm. There is a heat exchanger to provide the heat needed for the gasification reactions. The gasifier will operate at about 850°C and the biomass throughput will be about 950 kg/h. The amount of gas that is to be produced will be about 1 300 kg/h or 1 900 Nm^3/h. Part of the gas obtained will be burned in an external combustor to provide the heat for the gasifier. The gas turbine to be employed is a single shaft turbine designed to drive 750 kVA electrical generator. The turbine combustion chamber is somewhat modified to allow for the lower heating value of the gas. However, there is no loss of efficiency in the turbine output due to lower calorific value of the fuel. The turbine inlet temperature is 900/°C and that of the exhaust will be 500°C. The amount of gas to be used is about 745 Nm^3/h. The paper reports the experimental results obtained from a pilot-scale gasifier operating under similar conditions. The results of test runs carried out with a gas turbine are also presented.

6416 (NREL/CP–200-5768-Vol.1, pp. 521-537) **Fuel conversion efficiency and energy balance of a 400 kW$_t$ fluidized bed straw gasifier.** Erguedenler, A. (Technical Univ. of Nova Scotia, Halifax (Canada)); Ghaly, A.E.; Hamdullahpur, F. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

A 400 kW (thermal) dual-distributor type fluidized bed gasifier developed for the energy recovery from cereal straw was used to investigate the effects of equivalence ratio (actual air-fuel ratio: stoichiometric air-fuel ratio), fluidization velocity and bed height on the fuel conversion efficiency from wheat straw. The energy balance was also performed on the system under those operating conditions. The results indicated that the equivalence ratio was the most significant parameter affecting the fuel conversion efficiency and the energy recovered from the straw in the form of gas. Both the fuel conversion efficiency and the energy recovery increased with increases in the equivalence ratio. The fluidization velocity and bed height had minimal effects on these parameters. A fuel conversion efficiency as high as 98% was obtained at the equivalence ratio of 0.35. The energy recovered in the form of gas and the sensible heat of the produced gas were in the ranges of 40–70% and

9–17%, respectively. Unaccounted losses showed a dramatic increase at lower equivalence ratios and were in the range of 6–53% depending on the operating condition.

6417 (NREL/CP–200-5768-Vol.1, pp. 538-556) **Evaluation of energy plantation crops in a high-throughput indirectly heated biomass gasifier.** Paisley, M.A. (Battelle, Columbus, OH (United States)); Litt, R.D. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Experiments were run in Battelle's 10 ton per day Process Research Unit (PRU) gasifier using two high-growth, energy plantation crops – hybrid poplar – and an herbaceous biomass crop – switch grass. The results show that both feedstocks provide gas production rates, product gas compositions, and heating value similar to other biomass feedstocks tested in the Battelle gasification process. The ash compositions of the switch grass and hybrid poplar feedstocks were high in potassium relative to previously tested biomass feedstocks. High growth biomass species tend to concentrate minerals such as potassium in the ash. The higher potassium content in the ash can then cause agglomeration problems in the gasification system. A method for controlling this agglomeration through the addition of small amounts (approximately 2 percent of the wood feed rate) of an additive could adequately control the agglomeration tendency of the ash. During the testing program in the PRU, approximately 50 tons of hybrid poplar and 15 tons of switch grass were gasified to produce a medium Btu product gas.

6418 (NREL/CP–200-5768-Vol.1, pp. 557-570) **Development of a catalytic system for gasification of wet biomass.** Elliott, D.C. (Pacific Northwest Lab., Richland, WA (United States)); Sealock, L.J.; Phelps, M.R.; Neuenschwander, G.G.; Hart, T.R. National Renewable Energy Lab., Golden, CO (United States). [1993]. DOE Contract AC06-76RL01830. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

A gasification system is under development at Pacific Northwest Laboratory that can be used with high-moisture biomass feedstocks. The system operates at 350°C and 205 atm using a liquid water phase as the processing medium. Since a pressurized system is used, the wet biomass can be fed as a slurry to the reactor without drying. Through the development of catalysts, a useful processing system has been produced. This paper includes assessment of processing test results of different catalysts. Reactor system results including batch, bench-scale continuous, and engineering-scale processing results are presented to demonstrate the applicability of this catalytic gasification system to biomass. The system has utility both for direct conversion of biomass to fuel gas or as a wastewater cleanup system for treatment of unconverted biomass from bioconversion processes. By the use of this system high conversions of biomass to fuel gas can be achieved. Medium-Btu is the primary product. Potential exists for recovery/recycle of some of the unreacted inorganic components from the biomass in the aqueous byproduct stream.

6419 (NREL/CP–200-5768-Vol.1, pp. 640-648) **Temperature and pressure distributions in a 400 kW_t fluidized bed straw gasifier.** Erguedenler, A. (Technical Univ. of Nova Scotia, Halifax (Canada)); Ghaly, A.E.; Hamdullahpur, F. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The temperature and pressure distribution characteristics of a 400 kW (thermal) dual-distributor type fluidized bed straw gasifier were investigated. The effects of the bed height, equivalence ratio (actual air-fuel ratio:stoichiometric air-fuel ratio) and fluidization velocity on the temperature and pressure variations in the gasifier were studied. Generally, the bed temperature reached the steady state condition within 15–20 minutes. The average temperature of the dense bed ranged from 649°C to 875°C depending on the levels of operating parameters used. The bed temperature increased linearly with increases in the equivalence ratio, higher bed temperatures were observed with lower bed height and no clear trend for the bed temperature with respect to variations in fluidization velocity was observed. The bed height, equivalence ratio and fluidization velocity affected the pressure drop in the fluidized bed gasifier. Increasing the fluidization velocity and/or decreasing the equivalence ratio resulted in higher pressure drops in the dense bed and the freeboard regions whereas increasing the bed height increased the pressure drop only in the dense bed.

6420 (NREL/CP–200-5768-Vol.1, pp. 664-679) **Utilization of agricultural waste in power production.** Clausen, J.C. (ELSAM-PROJEKT A/S, Fredericia (Denmark)); Rasmussen, I. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

It is a goal of the Danish energy policy for the last decade to reduce energy consumption and to introduce fuels for power production with less CO_2 emission than coal. This measure has caused a considerable effort by the Danish utilities to develop technologies that reduce CO_2 emissions without causing heavy cost increases of power. Agricultural waste in the form of surplus straw is available in an amount equivalent to 20% of the annual coal imports to Denmark. Straw firing is difficult due to its significant contents of alkaline components. Consequently, its utilization presupposes the development of new technologies. The biomass development program is concentrated on two ways which are (1) co-firing of existing coal fired power station with a modest amount of straw and (2) development of CFB technology that allows a high share of biomass as well as coal only. These options were tested in a coal fired 70 MW spreader stoker unit and a 125 MW PF unit. Approx. 4000 t of straw were burned. Additional tests will be launched this autumn, burning 35,000 t of straw at rates up to 20% straw. The CFB option is pursued from the platform of a 80 MWth unit, operational early '92. This plant burns a mix of 50% straw and 50% coal and consumes annually 70.000 t of straw. Future development is aiming towards CFBs of 250 MW(e), burning in excess of 50% biomass.

6421 (NREL/CP–200-5768-Vol.1, pp. 712-717) **Pilot scale cotton gin trash energy recovery.** Harp, S.L. (Oklahoma State Univ., Stillwater, OK (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

During the summer of 1992 a 520,000 kcal/h (2,064,400 Btu/hr) biomass combustor was installed at a cotton gin in southwestern Oklahoma. The gin has a capacity of approximately 35 bales per hour. Each bale of cotton ginned weighs about 227 kg (500 lb) and produces about 68 kg (150 lb) of trash. Therefore, this gin produces about 52,360 kg (115,500 lb) of trash per day during a typical ginning season. Approximately 2 million kg (4 million lb) of gin trash are produced at this site each year. Cotton must first be dried to about 3-5% moisture content before the ginning process is begun. To accomplish this at this gin, two six million Btu/hour direct fired gas heaters are used to heat air for drying the cotton. The biomass combustor was installed to operate in parallel with one of the heaters to supply heated air for the drying process. A pneumatic conveying system was installed to intercept a portion of the gin trash and divert it to the burner. The burner was operated during the 1992 ginning season, which lasted from September through November, with few problems.

6422 (NREL/CP–200-5768-Vol.1, pp. 789-796) **The experience of burning the high-moistured waste of biomass conversion.** Fincker, F.Z. (MGVP Polytechenergo, St. Petersburg (Russian Federation)); Zysin, L.V.; Kubyshkin, I.B. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Industrially developed countries have a large stock of operating boiler plants to utilize timber industry waste materials (bagasse, bark, wood chips, hydrolytic lignine, sawdust, etc.) for biogenesis of energy. Standard combustion methods employing a bed or flare process cannot guarantee a reliable and economic boiler plant operation with abruptly changing biomass characteristic features. The moisture content in bark or lignin can vary from 50 to 75% during an hour. Particle sizes can vary from powdered to very large, and can have a hundred thousand times size difference. Large metal and mineral inclusions into the starting fuel also complicate the process. The low-temperature whirling combustion technology developed in Russia was taken as a basic. An economical and stable operation of boilers has been achieved by means of up-to-date vortex chamber aerial dynamics, the use of unique devices of fuel feed and preparation with screening the waste materials into sizes. The firing chamber is equipped with a multi-chamber device where screening and fuel particles preparation with the removal of non-combustible inclusions take place. At presenting the firing chamber with multi-step process of burning is in operation with 20 boilers. The firm "POLYTECHENERGO," a developer and producer of such equipment, carries out the modernization of the boiler plant without changes in the its thermal circuit. In most of cases no replacement of draught means is needed. Competitive with the proposed low-temperature whirling technological process can be only a fluidized bed process, but due to the complexity in service, low reliability, high energy expenditures, such chambers at present are very few. The capital expenses one existing boilers updating for a fluidized bed process exceed the expenses on a low-temperature whirling process by 15–20 fold.

6423 (NREL/CP–200-5768-Vol.2, pp. 891-901) **Progress report Idaho on-road test with vegetable oil as a diesel fuel.** Reece, D. (Univ. of Idaho, Moscow, ID (United States)); Peterson, C.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Biodiesel is among many biofuels being considered in the US for alternative fueled vehicles. The use of this fuel can reduce US dependence on imported oil and help improve air quality by reducing gaseous and particulate emissions. Researchers at the Department of Agricultural Engineering at the University of Idaho have pioneered rapeseed oil as a diesel fuel substitute. Although UI has conducted many laboratory and tractor tests using raw rapeseed oil and rape methyl ester (RME), these fuels have not been proven viable for on-road applications. A biodiesel demonstration project has been launched to show the use of biodiesel in on-road vehicles. Two diesel powered pickups are being tested on 20 percent biodiesel and 80 percent diesel. One is a Dodge 3/4-ton pickup powered by a Cummins 5.9 liter turbocharged and intercooled engine. This engine is direct injected and is being run on 20 percent RME and 80 percent diesel. The other pickup is a Ford, powered by a Navistar 7.3 liter, naturally aspirated engine. This engine has a precombustion chamber and is being operated on 20 percent raw rapeseed oil and 80 percent diesel. The engines themselves are unmodified, but modifications have been made to the vehicles for the convenience of the test. In order to give maximum vehicle range, fuel mixing is done on-board. Two tanks are provided, one for the diesel and one for the biodiesel. Electric fuel pumps supply fuel to a combining chamber for correct proportioning. The biodiesel fuel tanks are heated with a heat exchanger which utilizes engine coolant circulation.

6424 (NREL/TP–430-5597) **The direct observation of alkali vapor species in biomass combustion and gasification.** French, R.J.; Dayton, D.C.; Milne, T.A. National Renewable Energy Lab., Golden, CO (United States). Jan 1994. 89p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000262. Source: OSTI; NTIS; GPO Dep.

This report summarizes new data from screening various feedstocks for alkali vapor release under combustion conditions. The successful development of a laboratory flow reactor and molecular beam, mass spectrometer interface is detailed. Its application to several herbaceous and woody feedstocks, as well as a fast-pyrolysis oil, under 800 and 1,100°C batch combustion, is documented. Chlorine seems to play a large role in the facile mobilization of potassium. Included in the report is a discussion of relevant literature on the alkali problem in combustors and turbines. Highlighted are the phenomena identified in studies on coal and methods that have been applied to alkali speciation. The nature of binding of alkali in coal versus biomass is discussed, together with the implications for the ease of release. Herbaceous species and many agricultural residues appear to pose significant problems in release of alkali species to the vapor at typical combustor temperatures. These problems could be especially acute in direct combustion fired turbines, but may be ameliorated in integrated gasification combined cycles.

6425 (NUTEK-VK–93-19) **System study of externally fired gas turbines in different applications.** Eidensten, L. (Royal Inst. of Tech., Stockholm (Sweden). Dept. of Heat Technology); Yan, Jinyue; Svedberg, G. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). Mar 1993. 31p. (In Swedish). Project NUTEK-566-031. Order Number DE94730413. Source: OSTI; NTIS.

An attractive way to use the externally fired gas turbine technology is to put this type of gas turbine in front of a conventional boiler for steam or hot water. The gas turbine then acts as a ventilator with high temperature preheated combustion air. The goal for this report has been to investigate by system studies a number of different cogeneration applications for externally fired gas turbines. The following types of biomass fueled cogeneration plants have been modelled in this study: CFB steam boiler and a back pressure turbine; Grate fired steam boiler and a back pressure turbine; Hot water boiler; Evaporative gas turbine cycle with a grate fired steam boiler and a back pressure turbine; Evaporative gas turbine cycle with a hot water boiler; and Evaporative gas turbine cycle with a hot water boiler and flue gas condensation. The calculations have been performed using a simulation program, the ASPEN PLUS. The marginal power efficiency for topping combustion using LPG is quite high. For the CFB steam boiler and grate fired steam boiler, about 46-51 % of the LPG fuel energy is converted to power. The power to heat ratio is gradually increased at part load of the plants. The main reason for this is that the externally fired gas turbine is running at full load even at part load for the biomass fired boiler. When an evaporative gas turbine cycle is introduced the total plant efficiency is markedly decreased, but at the same time the power to heat ratio is drastically increased. It is shown that if the externally fired gas turbine is coupled to the biomass fired boiler in such a way that the gas turbine exhaust gas is used as combustion air in the boiler, then it is very hard to optimize both the externally fired gas turbine cycle and the cycle coupled to the boiler at the same time. This is specially true for the evaporative gas turbine cycle. 10 refs, 13 figs, 4 tabs

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Refer also to citation(s) 6337, 6338, 6339, 6342, 6346, 6348, 6353, 6362, 6364, 6368, 6370, 6372, 6403, 6409

6426 (DOE/CH/10093–206) **Profiles in renewable energy: Case studies of successful utility-sector projects.** Anson, S.; Sinclair, K.; Swezey, B. National Renewable Energy Lab., Golden,

CO (United States). Oct 1993. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE93000081. Source: OSTI; NTIS; GPO Dep.

As considerations of fuel diversity, environmental concerns, and market uncertainties are increasingly factored into electric utility resource planning, renewable energy technologies are beginning to find their place in the utility resource portfolio. This document profiles 10 renewable energy projects, utilizing six different renewable resources, that were built in the US throughout the 1980s. The resources include: biomass, geothermal, hydropower, photovoltaics, solar thermal, and wind. For each project, the factors that were key to its success and the development issues that it faced are discussed, as are the project's cost, performance, and environmental impacts and benefits.

6427 (IMES-EESS–9) **Evaluating alternatives: Aspects of an integrated approach using ethanol in Thailand's transportation sector.** Wilson, Deborah. Lund Inst. of Tech. (Sweden). Dept. of Environmental and Energy Systems Studies. Apr 1993. 42p. Order Number DE94730406. Source: OSTI; NTIS; INIS.

Part of LUTFD2-TFEM–93-1003.

Growing awareness of the negative social, environmental and economic impacts caused by the production, distribution and end-use consumption of energy has led the search for alternatives to become increasingly urgent and complex. The need for analytical methods and tools for evaluating options and opportunities is particularly acute in rapidly developing countries. The aim of this article is to illustrate the broad range of issues and impacts that are important for evaluating and comparing energy system alternatives in the context of sustainable development. A case study exploring the feasibility of producing and utilizing biomass based ethanol as an alternative transportation fuel in Thailand is used herein to provide examples and a forum for discussion of these issues. Scenarios describe the conditions under which a significant potential for fuel switching to domestically produced ethanol appears to exist. Harnessing this potential could lead to important improvements in the energy system's impacts on human health, Thailand's economy, and the environment. Achieving these improvements, however, would require comprehensive and long-term planning and support on the part of the Thai government. 91 refs, 11 tabs, 2 figs

6428 (NREL/CP–200-5768-Vol.1, pp. 18-32) **Projected wood energy impact on US forest wood resources.** Skog, K.E. (USDA Forest Service, Madison, WI (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The USDA Forest Service has developed long-term projections of wood energy use as part of a 1993 assessment of demand for and supply of resources from forest and range lands in the United States. To assess the impact of wood energy demand on timber resources, a market equilibrium model based on linear programming was developed to project residential, industrial, commercial, and utility wood energy use from various wood energy sources: roundwood from various land sources, primary wood products mill residue, other wood residue, and black liquor. Baseline projections are driven by projected price of fossil fuels compared to price of wood fuels and the projected increase in total energy use in various end uses. Wood energy use is projected to increase from 2.67 quad in 1986 to 3.5 quad in 2030 and 3.7 quad in 2040. This is less than the DOE National Energy Strategy projection of 5.5 quad in 2030. Wood energy from forest sources (roundwood) is projected to increase from 3.1 billion (10^9) ft^3 in 1986 to 4.4. billion ft^3 in 2030 and 4.8 billion ft^3 in 2040 (88, 124 and 136 million m^3, respectively). This rate of increase of roundwood use for fuel – 0.8 percent per year – is virtually the same as the projected increase rate for roundwood for pulpwood. Pulpwood roundwood is projected to increase from 4.2 billion ft^3 in 1986 to 6.0 billion ft^3 in 2030 and 6.4 billion ft^3 in 2040 (119, 170 and 183 million m^3, respectively).

6429 (NREL/CP–200-5768-Vol.1, pp. 54-67) **Evaluating a biomass resource: The TVA region-wide biomass resource assessment model.** Downing, M. (Oak Ridge National Lab., TN (United States)); Graham, R.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. DOE Contract AC05-84OR21400. Contract TV-87041V. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The economic and supply structures of short rotation woody crop (SRWC) markets have not been established. Establishing the likely price and supply of SRWC biomass in a region is a complex task because biomass is not an established commodity as are oil, natural gas and coal. In this study we project the cost and supply of short-rotation woody biomass for the TVA region – a 276 county area that includes all of Tennessee and portions of 10 contiguous states in the southeastern United States. Projected prices and quantities of SRWC are assumed to be a function of the amount and quality of crop and pasture land available in a region, expected SRWC yields and production costs on differing soils and land types, and the profit that could be obtained from current conventional crop production on these same lands. Results include the supply curve of SRWC biomass that is projected to be available from the entire region, the amount and location of crop and pasture land that would be used, and the conventional agricultural crops that would be displaced as a function of SRWC production. Finally, we show the results of sensitivity analysis on the projected cost and supply of SRWC biomass. In particular, we examine the separate impacts of varying SRWC production yields.

6430 (NREL/CP–200-5768-Vol.1, pp. 74-78) **TVA GIS-based biomass resource assessment.** Noon, C.E. (Univ. of Tennessee, Knoxville, TN (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The focus of this paper is a computer-based system for estimating the costs of supplying wood fuel. The system is being developed for the Tennessee Valley Authority and is referred to as the Biomass Resource Assessment Version One (BRAVO) system. The main objective in developing the BRAVO system is to assist TVA in estimating the costs for supplying wood fuel to any one of its twelve coal-fired plants. The BRAVO system is developed within a Geographic Information System (GIS) platform and is designed to allow a user to perform "what if" analyses related to the costs of wood fuel supply. Three types of wood fuel are considered in the BRAVO system: mill residues, logging residues and short-rotation woody crops (SRWC). Each type of wood fuel has unique economic and supply characteristics. The input data for the system includes the specific locations, amount, and prices of the various types of wood fuel throughout the TVA region. The system input is completed by data on political boundaries, power plant locations, road networks and a model for estimating transportation costs as a function of distance. The result is a comprehensive system which includes information on all possible wood fuel supply joints, demand points and product movement costs. In addition, the BRAVO system has been designed to allow a user to perform sensitivity analysis on a variety of supply system parameters. This will enable TVA to thoroughly investigate the financial impacts of issues such as increased competition for wood fuel, environmental policies, fuel taxes, and regional economic cycles.

6431 (NREL/CP–200-5768-Vol.1, pp. 106-111) **An evaluation of the regional supply of biomass at three midwestern sites.** English, B.C. (Univ. of Tennessee, Knoxville, TN (United States)); Dillivan, K.D.; Ojo, M.A.; Alexander, R.R.; Graham, R.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass*

Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1. 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Research has been conducted on both the agronomy and the conversion of biomass. However, few studies have been initiated that combine the knowledge of growing biomass with site specific resource availability information. An economic appraisal of how much biomass might be grown in a specific area for a given price has only just been initiated. This paper examines the economics of introducing biomass production to three midwest representative areas centered on the following counties, Orange County, Indiana; Olmsted County, Minnesota; and Cass County, North Dakota. Using a regional linear programming model, estimates of economic feasibility as well as environmental impacts are made. At a price of $53 per metric ton the biomass supplied to the plant gate is equal to 183,251 metric tons. At $62 per metric ton the biomass supply has increased to almost 1 million metric tons. The model predicts a maximum price of $88 per metric ton and at this price, 2,748,476 metric tons of biomass are produced.

6432 (NREL/CP–200-5768-Vol.1, pp. 272-277) **Evaluating the economics of biomass energy production in the Watts Bar region.** Alexander, R.R. (Univ. of Tennessee, Knoxville, TN (United States)); English, B.C.; Bhat, M.G.; Graham, R.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

While the commercial potential of biofuel technology is becoming more feasible, it is not clear whether the supply of biomass feedstock will be available in competitive markets. In order to exploit the potential of biomass crops as a reliable source of biofuels, a significant commitment on the part of farmers to convert large amounts of cropland would be required. Dedicated energy crops have to compete with conventional crops which could result in significant interregional shifts in crop production. Those changes could further affect overall agricultural production, food prices, consumer spending, and government spending on farm programs. Evaluating these economic impacts provides important information for the ongoing debate. This research is a case study incorporating an existing power plant. The objective of this project is to evaluate the potential of short rotation woody crops as a fuel source in the Watts Bar facility located in eastern Tennessee. The appraisal includes estimates of environmental impacts as well as of economic feasibility. This is achieved by estimating the amounts of biomass that would be supplied at a predetermined price. By changing prices of biomass at the plant in an incremental fashion, a regional supply curve for biomass is estimated. The model incorporates current agricultural production possibilities in the region along with the proposed short rotation woody crop production activities. In order to adequately model the landscape, several variables are considered. These variables include soil type, crop production, government policy, land use conversion to crop land, and distance from the plant. Environmental issues including erosion, chemical usage, and potential leaching are also incorporated within the modeling framework; however, only estimates on erosion are available in this analysis. Output from the model provides insight on where and what types of land should shift from current land use to biomass production.

6433 (NREL/CP–200-5768-Vol.1, pp. 448-453) **Assessment of ethanol-fueled IMHEX® fuel cell power plants in distributed generation.** Woods, R. (M-C Power Corp., Burr Ridge, IL (United States)); Lefeld, J. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Ethanol-fueled cell power plants presents several significant opportunities for the power generation industry. The potential exists to reduce pollution, help the nation shift from its dependence on imported fuels, reduce global warming, and strengthen the economy. Two important developments can be merged to create a clean, high-technology, bio-based energy system: the production of ethanol fuels and the application of fuel cell power plants. Utilization of ethanol will be in dual-fueled applications initially, and evolve toward the primary fuel as the need for renewable energy sources increase and the economic competitiveness improves. This assessment addresses the major issues of this proposed concept and outlines the benefits anticipated to the environment, US agriculture, energy supplies, and electric power customers. Economic and technical aspects of the concept are also reviewed. One of PSI Energy's primary interests is the utilization of renewable fuels supplied by their customer base. The IMHEX® fuel cell is an advanced electric power generation technology currently under development by M-C Power. Commercial applications within the power generation industry are scheduled to begin during the late 1990s.

6434 (NREL/CP–200-5768-Vol.1, pp. 461-466) **Economical impact of the BIG/CC technology use on the sugar cane industry.** Queiroz, L.C. de (Brascep Engenharia Ltda., Rio de Janeiro (Brazil)); Nascimento, M.J.M. do. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The use of biomass as primary fuel for power and steam production using modern conversion technology such as the Biomass Integrated Gas Turbine/Combined Cycle (BIG/CC) has both technical and commercial potential. Brazil is implementing a BIG/CC Demonstration Plant to burn wood from eucalyptus short rotation forest and to test sugar cane bagasse as feedstock. The purpose of this project is to demonstrate the commercial viability of using biomass as a feedstock for power generation, its suitability for applications in developing countries, and the possibilities it offers for commercial activities in regions which currently have a low level of economic activities. The purpose of this paper is to show the potential applicability of this technology in the sugar cane industries of Developing Countries such as Brazil. The same quantity of sugar cane already processed in each sugar mill can produce sizable quantities of electric power at competitive costs, in addition to the traditional products – sugar and/or ethanol, which will cause an economical impact, duplicating the revenue of these industries. The application of the BIG/CC technology in the Sugar Cane Industry may lead to the following scenario in developing countries: (1) power shall be produced at very competitive prices by specialized private firms associated with sugar mills; (2) plant sizes will be smaller – 15 to 100 MW – when based on biomass, a compared to large fossil fuel plants now prevailing; (3) ethanol and sugar production costs will be reduced due to more efficient and economical processes and due to the additional revenue from power production; (4) becoming more competitive with gasoline, ethanol production tends to increase, which will influence the automobile industry and improve the quality of life in big cities.

6435 (NREL/CP–200-5768-Vol.1, pp. 742-746) **The biomass energy industry of northern New England: Lessons for America.** Connors, J.F. (Maine State Planning Office, Augusta, ME (United States)); Keeney N.H III. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The successful development of biomass energy for electricity generation in northern New England (Maine, New Hampshire) was launched by new innovative public policies and the relative competitive advantages of ample supplies of wood residues and forest biomass. Since 1980 over 600 megawatts of wood-fired capacity has been developed, and generates nearly 20% of the two state electricity supply. What are the factors that account for this dramatic development, and what are the lessons for the rest of the

America's? This paper summarizes the influences of public policies, the importance of extensive resources, the power needs of the utilities, the business/investment opportunities for IPP's, and native strengths in fuel procurement and wood combustion experience. Conclusions are drawn in the form of lessons for other regions, and jurisdictions concerned with attaining the benefits of biomass energy development.

6436 (NREL/CP–200-5768-Vol.1, pp. 770-782) **Biomass power production in Amazonia: Environmentally sound, economically productive.** Waddle, D.B. (National Rural Electric Cooperative Association, Washington, DC (United States)); Hollomon, J.B. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

With the support of the US Agency for International Development, the National Rural Electric Cooperative Association (NRECA) is assisting their utility counterparts in Bolivia to improve electric service in the country's rural population. In remote areas, the cost of extending transmission lines to small communities is prohibitive, and diesel generators represent an expensive alternative, especially for baseload power. This has led to serious consideration of electric generating systems using locally available renewable resources, including biomass, hydro, wind, and solar energy. A project has recently been initiated in Riberalta, in the Amazonian region of Bolivia, to convert waste Brazil nut shells and sawmill residues to electricity. Working in tandem with diesel generators, the biomass-fired plant will produce base-load power in an integrated system that will be able to provide reliable and affordable electricity to the city. The project will allow the local rural electric cooperative to lower the price of electricity by nearly forty percent, enable the local Brazil nut industry to increase its level of mechanization, and reduce the environmental impacts of dumping waste shells around the city and in an adjacent river. The project is representative of others that will be funded in the future by NRECA/AID.

6437 (NREL/CP–200-5768-Vol.2, pp. 1159-1172) **Current and future market developments for fuel alcohols and ethers.** Miller, K.D. Jr. (DeWitt & Co., Inc., Houston, TX (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Methanol, ethanol and several mid-range ethers are oxygen-containing compounds which are used today as motor gasoline blendstocks, and which will see a dramatic growth as the US Clean Air Act comes into full effect. Oxygenated compounds have high octane characteristics, and their use is mandated by the Law in about half of US gasoline after 1995 since they have been found to reduce tailpipe emissions when blended into gasoline. This paper describes the physical and chemical characteristics of the major compounds, and describes the advantages and disadvantages of each. Market projections are presented for the United States, and in a general way for the rest of the world.

6438 (NREL/CP–200-5768-Vol.2, pp. 1173-1184) **The economic characteristics of the US fuel ethanol market.** Rask, K.N. (Colgate Univ., Hamilton, NY (United States)); Rask, N. National Renewable Energy Lab., Golden, CO (United States). [1993]. Grant SBR-9223665. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Ethanol has become an increasingly important fuel additive in the US over the past decade. Recent clean-air legislation has mandated the use of cleaner burning fuels in specific regions and seasons across the US. The fundamental role of fuel ethanol is changing from an octane enhancing gasoline substitute to one of a number of possible clean-air additives. In addition to these changing market conditions the institutional structure surrounding the ethanol market has changed. While there is a uniform national subsidy for ethanol use, each state has its own supplemental subsidy level which can vary from zero to $.40 per gallon. State subsidy levels have been declining. This paper uses data from 1984:1 through 1990:12 and explores the economic characteristics of the US ethanol market so that possible supply responses to new clean-air legislation can be addressed. Specific issues regarding whether we have individual state-level markets or a national market are discussed. The implications of this market structure are important for determining state and federal subsidies and their possible impact on budget deficits.

6439 (NREL/CP–200-5768-Vol.2, pp. 1185-1193) **Fuel ethanol production in Brazil.** Macedo, I.C. (Centro de Tecnologia Copersucar, Piracicaba (Brazil)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The Brazilian ethanol from sugar cane program is the largest commercial liquid fuel from biomass system in operation today, with a production of 12 million m^3 ethanol/year. During its 15 years of existence many issues were considered, under varying economic and strategic conditions. An overview is presented of the program development, present situation and main trends. Main subjects are technology development and implementation, costs, environmental benefits and constraints, and social/institutional issues. Is shown that the debate over the program has led to a sound knowledge on key issues (energy and CO_2 balance, technology level and cost reduction, agricultural mechanization and job creation, land utilization, urban-air pollution effects, ethanol distribution, blending and use in dedicated engines.) With this basic knowledge some trends for the near future are considered (gains in productivity/conversion efficiency and cost implications; change to unburnt cane harvesting and technology development for cane trash conversion).

6440 (NREL/CP–200-5768-Vol.2, pp. 1201-1214) **Chemicals and products from biomass conversion: An overview.** Chum, H.L. (National Renewable Energy Lab., Golden, CO (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Developing chemicals and materials from biomass is reviewed from a historical perspective. The efforts during the 1970'S oil crises seeded a firmer understanding of the renewable resource base. Major industrial successes in chemicals from biomass have not yet implemented, but several new commercial products are approaching the market place. The cost, availability and distribution of oils was the driver for the '70s; the driver for the efforts of the '90s is environmentalism. Similarities are recalled and differences in philosophies highlighted. Biomass has several opportunities to enter chemical and material markets as well as the energy market in the '90s. The future or organic raw material is closely related to that of energy and these two together, in a well-designed strategy will boost renewable energy development, employment, and add strength to regional industrial development. In addition, they will provide agricultural producers with more income security with new and stable markets for products. National and international government policies have a substantial role to play. Fiscal measures and social policies can help or hinder the development of new resources and investment decisions. For industry to invest in new technologies that are inherently a higher risk industry and government must work together. Nearly 20 years of developing specific areas has brought us closer to commercial implementation. However, the span of times from technology development to implementation in most of these activities is about 40-50 years because in many

cases, radically new processes and products are being created. It is essential to maintain critical capabilities to sustain their development. Appropriate partnerships between industry, government, and academia can lead to intelligent use of natural renewable resources to continually increase regional and national economic development, and provide a clean and sustainable environment.

6441 (NREL/CP–200-5768-Vol.2, pp. 1448-1455) **Commercial production of specialty chemicals and pharmaceuticals from biomass.** McChesney, J.D. (Univ. of Mississippi, University, MS (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The chemical substances utilized in consumer products, and for pharmaceutical and agricultural uses are generally referred to as specialty chemicals. These may be flavor or fragrance substances, intermediates for synthesis of drugs or agrochemicals or the drugs or agrochemicals themselves, insecticides or insect pheromones or antifeedants, plant growth regulators, etc. These are in contrast to chemicals which are utilized in large quantities for fuels or preparation of plastics, lubricants, etc., which are usually referred to as industrial chemicals. The specific utilization of specialty chemicals is associated with a specific important physiochemical or biological property. They may possess unique properties as lubricants or waxes or have a very desirable biological activity such as a drug, agrochemical or perfume ingredient. These unique properties convey significant economic value to the specific specialty chemical. The economic commercial production of specialty chemicals commonly requires the isolation of a precursor or the specialty chemical itself from a natural source. The discovery, development and commercialization of specialty chemicals is presented and reviewed. The economic and sustainable production of specialty chemicals is discussed.

6442 (NREL/CP–200-5768-Vol.2, pp. 1456-1471) **Commercial charcoal manufacture in Brazil.** Rezende, M.E. (Tecnologia e Meio Ambiente, Belo Horizonte (Brazil)); Lessa, A.; Pasa, V.; Sampaio, R.; Macedo, P. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Brazil is the only country where charcoal has a major industrial us. Almost 40% of the pig iron and all the ferroalloys produced in the country are based on it and were established near Minas Gerais iron ore deposits using non-sustainable farm charcoal. Since the 1980s charcoal production from large eucalyptus forests is gradually increasing, accounting for 40% of the 8 million tonnes produced in 1991. Farm charcoal is produced when native forests are slashed to give way to farm land. Adequate techniques, labor rights or environmental concerns are not common in this scenario. In large eucalyptus forests charcoal production has a different business approach. Several kinds of masonry ovens are used in both scenarios. Continuous carbonization kilns are not feasible yet because of their high capital cost. The search for a new cheapest design or for the upgrading of the carbonization byproducts is a must. Promising results are shown. Plastics and fine chemicals were already obtained from wood tar. The first Brazilian pilot plant for wood tar fractionation will be started by 9/93. Ironworks have different profiles. Some plants are up-to-date integrated mini-steelworks. Others are small producers of pig ingots. They have in common the need to face coke ironmaking route. Brazilian exports of charcoal based iron and steel products have attained the goal until now. Future charcoal competitiveness will not be so easy. Although expertises believe that coke prices can not stand low for long time it poses additional difficulty to the Brazilian charcoal ironmaker. Three scenarios projected for the future of charcoal ironmaking show that as long as charcoal production costs are properly managed, charcoal will be competitive with coke. The authors defend a common research program that looks for technologies suited to the Brazilian reality.

0940 Transport, Handling, and Storage

6443 (NREL/CP–200-5768-Vol.1, pp. 326-333) **Acquisition of wood fuel at the Joseph C. McNeil Generating Station.** Kropelin, W. (Burlington Electric Dept., VT (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The Joseph C. McNeil Generating Station is the world's largest single boiler, municipally-owned, wood-fired electrical generating plant. The 50 megawatt McNeil Station is located in Burlington, Vermont and is owned by several Vermont public and private electric utilities. The operator and majority owner is the City of Burlington Electric Department (BED). Wood fuel procurement for the McNeil Station has been conducted in an environmentally sensitive way. Harvesting is carried out in conformance with a comprehensive wood chip harvesting policy and monitored by professional foresters. Unpredictable levels of Station operation require rigid adherence to a wood storage plan that minimizes the risk of over heating and spontaneous combustion of stockpiled fuel.

6444 (NREL/CP–200-5768-Vol.1, pp. 334-340) **Principles of commercially available pretreatment and feeding equipment for baled biomass.** Koch, T. (Thomas Koch Energi, Vanloese (Denmark)); Hummelshoej, R.M. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

During the last 15 years, there has been a growing interest in utilizing waste biomass for energy production in Denmark. Since 1990, it has been unlawful to burn surplus straw on open land. Before the year 2000, it is intended to utilize most of the 2–3 million tons of surplus straw as an energy resource. The type of plants that were built in the beginning were combustion plants for district heating. The feeding equipment for these plants has been developed to an acceptable standard. Later, combustion plants for combined heat and power production based on a steam turbine were introduced. This type of plant demands a much greater continuity in the fuel flow, and the consequences of minor discontinuities are to be dropped from the grid. Gasification and pyrolysis demands a high sealing ability of the feeding equipment, because of the explosive and poisonous gas in the plant and a need for a very high continuity in the fuel feed. The first plants were built with the equipment and experiences from the farming industries, which have a long tradition in working with biomass-handling. The experiences gained with this type of equipment were not very promising, and in the early eighties, a more industrial type of biomass-handling equipment was developed. This paper presents the principles of the heavy-duty biomass pretreatment and feeding equipment that was commercially available in Denmark in May, 1993.

0950 Environmental Aspects

Refer also to citation(s) 6362, 6368, 6420, 6428, 6433, 6436, 6772, 7392

6445 (ETSU-B/W–5/00340/REP) **Public perceptions of short rotation coppice.** Sadler, R. Saint Ronans Research, Whitley Bay (United Kingdom). 1993. 76p. Sponsored by AEA Environment and Energy, Harwell (United Kingdom). Order Number DE94730468. Source: OSTI; NTIS (US Sales Only); INIS.

The "Wood as a Fuel" programme - which funded the research covered in this report - is one of the renewable energy development programmes managed by ETSU (the Energy Technology Support

Unit) for the Department of Trade and Industry. This national programme is developing the production and use of fuel wood from two main sources - forestry residues and short rotation coppice. Wood fuel from short rotation coppice offers the greater potential - energy equivalent to 10 mtce (million tonnes of coal equivalent) could be produced annually from 1 million hectares of land. This programme is now well established, with ten trial coppice sites in operation, plus some 40 others. A number of successfully willow and poplar clones have been selected for different soil conditions, and machinery for planting and harvesting has been developed. Local consortia of farmers and users are being established to provide long-term markets for the wood fuel produced. (author)

6446 (NREL/CP–200-5768-Vol.1, pp. 33-41) **Some ecological guidelines for large-scale biomass plantations.** Hoffman, W. (National Audubon Society, Tavernier, FL (United States)); Cook, J.H.; Beyea, J. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The National Audubon Society sees biomass as an appropriate and necessary source of energy to help replace fossil fuels in the near future, but is concerned that large-scale biomass plantations could displace significant natural vegetation and wildlife habitat, and reduce national and global biodiversity. We support the development of an industry large enough to provide significant portions of our energy budget, but we see a critical need to ensure that plantations are designed and sited in ways that minimize ecological disruption, or even provide environmental benefits. We have been studying the habitat value of intensively managed short-rotation tree plantations. Our results show that these plantations support large populations of some birds, but not all of the species using the surrounding landscape, and indicate that their value as habitat can be increased greatly by including small areas of mature trees within them. We believe short-rotation plantations can benefit regional biodiversity if they can be deployed as buffers for natural forests, or as corridors connecting forest tracts. To realize these benefits, and to avoid habitat degradation, regional biomass plantation complexes (e.g., the plantations supplying all the fuel for a powerplant) need to be planned, sited, and developed as large-scale units in the context of the regional landscape mosaic.

6447 (NREL/CP–200-5768-Vol.1, pp. 724-729) **Emissions from laboratory combustor tests of manufactured wood products.** Wilkening, R. (Univ. of Wisconsin, Madison, WI (United States)); Evans, M.; Ragland, K.; Baker, A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Manufactured wood products contain wood, wood fiber, and materials added during manufacture of the product. Manufacturing residues and the used products are burned in a furnace or boiler instead of landfilling. Emissions from combustion of these products contain additional compounds from the combustion of non-wood material which have not been adequately characterized to specify the best combustion conditions, emissions control equipment, and disposal procedures. Total hydrocarbons, formaldehyde, higher aldehydes and carbon monoxide emissions from aspen flakeboard and aspen cubes were measured in a 76 mm i.d. by 1.5 m long fixed bed combustor as a function of excess oxygen, and temperature. Emissions of hydrocarbons, aldehydes and CO from flakeboard and from clean aspen were very sensitive to average combustor temperature and excess oxygen. Hydrocarbon and aldehyde emissions below 10 ppM were achieved with 5% excess oxygen and 1,200°C average temperature for aspen flakeboard and 1,100°C for clean aspen at a 0.9 s residence time. When the average temperature decreased below these levels, the emissions increased rapidly. For example, at 950°C and 5% excess oxygen the formaldehyde emissions were over 1,000 ppM. These laboratory tests reinforce the need to carefully control the temperature and excess oxygen in full-scale wood combustors.

0980 Waste Management

Refer also to citation(s) 6392

6448 (NEI-DK–1366) **Further development of Soft-Top for the accumulation of biogas from storage tanks.** Henriksen, K. Soft Top-Gruppen ApS, Farsoe (Denmark). Sep 1993. 12p. (In Danish). Contract ENS-51161-91.0063. Order Number DE94730346. Source: OSTI; NTIS.

In cooperation with Vegger Biogasanlaeg.

Since the first prototype of Soft-Top for covering storage tanks was invented and tested on the biomass conversion plant at Farsoe, Denmark, in 1990-91, the interest in coverings for storage tanks has grown. The advantages these coverings give are a better utilization of biomass' gas potential by the collection of wastes with gas potential in the storage tanks, the elimination of ammonia and methane emission to the atmosphere, the improvement of the value of nitrogen fertilizers in the degassed liquid manures and the reduction of odour emitted from the storage tanks. The Soft-Top covering was demonstrated on a storage tank in Vegger which has a volume of 600 cubic meters and an average inner diameter op 13.3 meters. It functions as a buffer storage before delivery to farmers and the degassed manure slurries remain in the tank for eight days. A Soft-Top is a floating, gas-tight membrane covering which follows the level of the manure slurry in the tank. It is based on over-pressure which means that the membrane is stretched by the gas pressure. It has a solid border and a floater of galvanized iron to which it is fixed. The biogas is sucked from the storage tank by a ventilator which, via a pressure transmitter and a transformer, regulates the pressure under the membrane. The methane is transported to the existing gas installation. The construction, which has been in operation since March, 1922, has shown itself to be stable in operation and the material is robust. The automatic control has functioned satisfactorily and can be controlled within an interval of 1mm water column. (AB)

6449 (NREL/CP–200-5768-Vol.1, pp. 680-688) **Case study of recycling options for New Hampshire generators.** Coleman, P.M. (Resource Conservation Services, Inc., Brunswick, ME (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The successful development of utilization programs for ash generated by the combustion of biomass in Northern New England is described, with special focus on the State of New Hampshire. With the development of over 25 large scale biomass boilers in Northern New England during the past ten years, has come the need to dispose of the over 300,000 cubic yards of ash produced as a combustion by-product. Resource Conservation Services, Inc., a private company, pioneered the development of various utilization options for biomass boiler ash. The major use of ash has been as an agricultural soil amendment. The high levels of calcium in wood ash make it valuable as a lime substitute for raising soil pH. Wood ash also contains significant levels of potassium, phosphorus and magnesium as well as lesser amounts of other plant nutrients which make it valuable as a fertilizer. Soil testing is used to determine application rates to agricultural land. Ash use is regulated by State environmental protection agencies. Heavy metal content of wood ash meets regulatory standards. Wood ash also proven valuable as a bulking and odor control material when mixed with municipal wastewater treatment plant sludge and composted. The high pH of wood ash controls odor producing compounds generated by the composting process. High carbon ash also controls odors through improved aeration and by adsorption of odor producing compounds by the "char" in the ash. Additional uses for wood ash are as a component of concrete products such as "flowable fill" and "soil cement," as a lime substitute for sludge stabilization, and

as landfill daily cover. As higher value uses for wood ash have been developed, ash disposal costs have been reduced and ash is viewed more like a commodity than a waste material.

0990 Products and By-Products

6450 (NREL/CP–200-5768-Vol.1, pp. 634-639) **Analysis of tars produced in biomass gasification.** Zhou, J. (Univ. of Hawaii, Honolulu, HI (United States)); Wang, Y.; Kinoshita, C.M. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Parametric tests on tar formation, varying temperature, equivalence ratio, and residence time, are performed on a bench-scale, indirectly-heated fluidized bed gasifier. Prepared tar samples are analyzed in a gas chromatograph (GC) with a flame ionization detector, using a capillary column. Standards containing dominant tar species have been prepared for GC calibration. The identified peaks include single-ring hydrocarbons, such as benzene, to five-ring hydrocarbons, such as perylene; depending on the gasification conditions, the identified species represent about 70 to 90% (mass basis) of the tar constituents. Under all conditions tested, benzene and naphthalene were the most dominant species. Temperature and equivalence ratio have significant effect on tar yield and tar composition. Tar yield decreases with increasing temperature or equivalence ratio. The test results suggest that lower temperature favors the formation of more aromatic tar species with diversified substituent groups, while higher temperature favors the formation of fewer aromatic tar species without substituent groups. Higher temperature or equivalence ratio favors the formation of polyaromatic compounds. Oxygen-containing compounds exist in significant quantities only at temperature below 800°C and decrease with increasing temperature, equivalence ratio, or residence time.

6451 (NREL/CP–200-5768-Vol.1, pp. 689-705) **Environmental issues: New techniques for managing and using wood fuel ash.** Fehrs, J.E. (C.T. Donovan Associates, Inc., Burlington, VT (United States)); Donovan, C.T. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Continued research and development of environmentally-acceptable and cost-effective end uses for wood ash is having a significant affect on the ability to use wood and wood waste for fuel. This is particularly true for ash resulting from treated wood combustion. Concerns about the contents of ash from wood containing paint, stain, preservatives, or other chemicals is one of the largest regulatory barriers to its use as fuel. The purpose of this paper is to: (1) Identify the physical and chemical characteristics of ashes produced from the combustion of untreated and treated wood; (2) Explain the types of "clean, untreated" and "treated" wood that are likely to produce ash that can beneficially used; (3) Describe existing and potential products and end uses for untreated and treated wood ash.

6452 (NREL/CP–200-5768-Vol.1, pp. 706-711) **Wood ash to treat sewage sludge for agricultural use.** White, R.K. (Clemson Univ., SC (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

About 90% of the three million tons of wood ash generated in the United States from wood burning facilities is being landfilled. Many landfills are initiated tipping fees and/or restrictions on the disposal of special wastes such as ash. The purpose of this work was to evaluate (1) the feasibility of using wood ash to stabilize sewage sludge and (2) the fertilizer and liming value of the sludge/ash mixture on plant response and soil pH. Research showed that wood ash, when mixed with sludge, will produce a pH above 12.0, which meets US EPA criteria for pathogen reduction for land application on non-direct food chain crops. Different ratios of wood ash to sludge mixtures were tested and the 1:1 ratio (by weight) was found to be optimal. Five replications of wood ash from four sources were tested for moisture content, pH and fertilizer nutrients. The pH of the ash/sludge mixture (1:1) on day one ranged from 12.4 to 13.2. In most cases the pH remained the same over a 21 day test or only dropped 0.1 to 0.3 units. Analyses of the mixtures showed that heavy metal concentrations (As, B, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, S, Se, Zn) were low. The 1:1 ash/sludge mixture had a calcium carbonate equivalency of 17%. Green house pot studies using tall fescue grass were loadings of 300 to 750 pounds per acre of TKN-N than for 500 lb/acre of 10-10-10 commercial fertilizer. Plant tissue analysis showed N, P, K, Ca, and Mg levels to be within the sufficiency range for tall fescue.

6453 (NREL/CP–200-5768-Vol.1, pp. 736-741) **Biomass ash utilization.** Bristol, D.R. (HYDRA-CO Operations, Inc., Syracuse, NY (United States)); Noel, D.J.; O'Brien, B.; Parker, B. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

This paper demonstrates that with careful analysis of ash from multiple biomass and waste wood fired power plants that most of the ash can serve a useful purpose. Some applications require higher levels of consistency than others. Examples of ash spreading for agricultural purposes as a lime supplement for soil enhancement in Maine and North Carolina, as well as a roadbase material in Maine are discussed. Use of ash as a horticultural additive is explored, as well as in composting as a filtering media and as cover material for landfills. The ash utilization is evaluated in a framework of environmental responsibility, regulations, handling and cost. Depending on the chemical and physical properties of the biomass derived fly ash and bottom ash, it can be used in one or more applications. Developing a program that utilizes ash produced in biomass facilities is environmentally and socially sound and can be financially attractive.

10 SYNTHETIC FUELS

1002 Production

6454 (DOE/PC/90042–T4) **Development of a catalyst for conversion of syngas-derived materials to isobutylene: Technical progress report No. 6, July 1, 1992–September 30, 1992.** Gajda, G.J. UOP, Inc., Des Plaines, IL (United States). 10 Sep 1993. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90042. Order Number DE94004520. Source: OSTI; NTIS; GPO Dep.

Goal is to develop a catalyst and technology that will produce iC_4= directly from coal-derived syngas and that is capable of using a lower H_2/CO ratio (0.5 to 1.0). This report covers the testing of various zirconia (ZrO_2) based catalyst systems designed to examine effects of catalyst preparation and process variables, especially feed additives. Testing sol-gel ZrO_2 catalysts calcined at 475 C instead of 500 C increases the isobutene yield. Supporting zirconia on high-surface-area sol-gel silica or silica-alumina results in low activity catalysts. Addition of ethylene, propylene, ethanol to feed produces hydrogenation, dimerization, and metathesis products, but little or no isobutene.

6455 (DOE/PC/90042–T7) **[Oxygenated octane enhancers: Syngas to isobutylene]: Technical progress report No. 8, January 1, 1993–March 31, 1993.** Barger, P.T. UOP, Inc., Des Plaines, IL (United States). 25 Oct 1993. 6p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC22-91PC90042. Order Number DE94005034. Source: OSTI; NTIS; GPO Dep.

The goal of this program is to develop a catalyst and a process for the conversion of syngas to isobutylene. However, due to the low conversion and selectivity generally experienced by the industry in direct conversion of syngas to isobutylene, indirect conversion via branched C_4 alcohol intermediates is being explored. The objectives of the current program are to develop a catalyst and process for the conversion of syngas to isobutanol and to evaluate the commercial potential of the new process. The research program underway at UOP will identify and optimize key catalyst and process characteristics. This report covers the modification and shake-down of a fixed-bed pilot plant (No. 700) for the testing of catalysts and catalyst combinations. A separate syngas feed system has been added to an existing fixed bed Fischer-Tropsch pilot plant and new reactors are constructed to avoid catalyst cross contamination. Shake-down testing with a commercial Cu/Zn/Al oxide catalyst alone and in combination with a basic Mg/Al MOSS (Metal Oxide Solid Solution) catalyst have demonstrated good CO and H_2 conversion. However, contamination of the product by residual Fischer-Tropsch product in the exit lines and the liquid gas chromatograph (GC) has prevented accurate product analyses. A separate exit system and liquid GC have been added to the plant for use by the higher alcohols synthesis project.

6456 (DOE/PC/90046–T4) **Heterogeneous catalytic process for alcohol fuels from syngas: Fourth quarterly technical progress report, October–December 1992.** Union Carbide Chemicals and Plastics Co., Inc., South Charleston, WV (United States). South Charleston Technical Center. [1992]. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC90046. Order Number DE94002160. Source: OSTI; NTIS; GPO Dep.

The principal objectives of this project are to discover and evaluate novel heterogeneous catalysts for conversion of syngas to oxygenates having use as fuel enhancers, to explore novel reactor and process concepts applicable in this process, and to develop the best total process for conversion of syngas to liquid fuels.

6457 (DOE/PC/91028–T7) **High pressure synthesis gas conversion: Task 2: Determination of maximum operating pressure.** Arkansas Univ., Fayetteville, AR (United States). Dept. of Chemical Engineering. May 1993. 44p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91028. Order Number DE94003301. Source: OSTI; NTIS; GPO Dep.

The purpose of this research project was to build and test a high pressure fermentation system for the production of ethanol from synthesis gas. The fermenters, pumps, controls, and analytical system were procured or fabricated and assembled in our laboratory. This system was then used to determine the effects of high pressure on growth and ethanol production by C. ljungdahlil. The limits of cell concentration and mass transport relationships were found in CSTR and immobilized cell reactors (ICR). The minimum retention times and reactor volumes were found for ethanol production in these reactors. The purpose of this report was to present the results of high pressure experiments aimed at determining the maximum operating pressure of C. ljungdahlil. Preliminary experiments carried out in approaching the pressure maximum are presented, as well as experimental results at the maximum pressure of 150 psig. This latter pressure was the maximum operating pressure when using the defined medium of Phillips et al., and is expected to change if alternative media are employed.

6458 (DOE/PC/91301–8) **Ethanol synthesis and water gas shift over bifunctional sulfide catalysts: Technical progress report, June 1993–August 1993.** Klier, K.; Herman, R.G.; Deemer, M.; Carr, T. Lehigh Univ., Bethlehem, PA (United States). Sep 1993. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91301. Order Number DE94003572. Source: OSTI; NTIS; GPO Dep.

Various preparation methods of synthesizing molybdenum disulfide and various alkali doping procedures were studied to determine if various preparation paramenters affected catalyst activity. Testing was performed on an undoped molybdenum disulfide sample with H_2/CO = 1 synthesis gas at 8.1 MPa and at temperatures of 245, 255, 265, 275, 280, 300, 320, and 295C, and only hydrocarbons were formed. A methanol injection experiment with undoped catalyst showed that homologation of methanol did not occur over the undoped MOS_2. Catalytic testing on a cesium formate doped molybdenum disulfide catalyst corresponding to 9 wt% Cs/MoS_2 at 8.1 MPa and temperatures of 245, 255, 265, 275, 285, and 295C, mostly linear alcohols. The CS/MOS_2 sample was protected from air exposure during preparation and testiag. As with the other recently tested alkali-promoted MOS_2 catalysts, this cataylst was not as active as previous CS/MOS_2 catalysts [1], and some deactivation during these systematic studies was observed. X-Ray powder diffraction and BET surface area measurements are being used to characterize the catalysts, and electron microscopy analyses are being carried out.

6459 (NREL/CP–200-5768-Vol.2, pp. 993-1009) **IEA technoeconimic sensitivity analysis of thermochemical conversion of wood to gasoline processes.** Bridgewater, A.V. (Aston Univ., Birmingham (United Kingdom)); Diebold, J.P.; Beckman, D.; Elliott, D.C.; Solantausta, Y. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The Liquefaction Group of the IEA Biomass Agreement has carried out a thorough techno-economic assessment of the NREL process to convert biomass to an aromatic gasoline product. In this process, biomass is flash pyrolysed in a vortex reactor to minimize the formation of oil vapors. After removing char, the oil vapors are immediately sent to a catalytic cracking reactor with ZSM-5 zeolite catalyst to form a mixture of aromatic gasoline and gaseous olefins. Gasoline is recovered and the by-product olefins are converted to form more aromatic gasoline. The primary product is gasoline with a very high blending octane which is expected to command a premium price. The technoeconomics of this process were determined for a present case based on technology considered to be commercially available as well as a future case in which a successful research and development program of process improvement is assumed. Capital cost estimates and product cost estimates are presented for both cases with sensitivity analyses on the major variables. The potential improvement in the potential or future case compared to the present case justifies continued research and development on the process technology.

1004 Combustion

Refer also to citation(s) 6862

6460 (NEDO-P–9224) **Feasibility study on introduction of a large methanol engine power generation plant.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 116p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE94732338. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

This paper studies a possibility of introducing a 2-cycle methanol diesel engine power generation plant. Since methanol is much in vaporizing latent heat and small in quantity of heat emission per unit weight when using it as fuel, observed are a decline in combustible range temperature and a large decrease in NOx emissions. As for thermal efficiency, generating end efficiency of 46% is expected by heat recovery in the case of 40-50 thousand kW class 2-cycle engines. The methanol engine has such excellent performance/characteristics as little lowering of efficiency at middle loads, possible numerical control, short starting time and high load change rate. The construction cost is approximately equal to that of the LNG steam power generation and is lower than that of the LNG combined cycle power generation. The unit power generation cost is lower than those of fuel cells and gas turbines and 2-3 yen/kW higher than those of the combined cycle and the reformed

turbines. However, it is found that methanol engines are most suitable to meet 200MW class demand. 52 refs., 68 figs., 19 tabs.

13 HYDRO ENERGY

Refer also to citation(s) 6329

1301 Resources and Availability

6461 (DOE/BP/21985–5) **Adjusted streamflow and storage: Columbia River and Coastal Basins, 1928–1989.** USDOE Bonneville Power Administration, Portland, OR (United States); Crook (A.G.) Co., Beaverton, OR (United States). Jul 1993. 337p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC79-92BP21985. Order Number DE94000948. Source: OSTI; NTIS; GPO Dep.

The development of irrigation projects since the 1830's and the construction of major dams and reservoirs since the early 1900's have altered substantially the natural streamflow regimen of the Columbia River and its tributaries. As development expanded a multipurpose approach to streamflow regulation evolved to provide flood control, irrigation, hydropower generation, navigation, recreation, water quality enhancement, fish and wildlife, and instream flow maintenance. The responsible agencies use computer programs to determine the effects of various alternative system regulations. This report describes the development of the streamflow data that these computer programs use.

1303 Plant Design and Operation

6462 (TRITA-VBI–162) **Pipeline transients and surge-tank stability.** Yang Xiaoliang. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Hydraulic Engineering. 1993. 57p. Order Number DE94730403. Source: OSTI; NTIS.

Evaluation of surge-control facilities for hydro power development is essential in order to achieve favourable hydraulic conditions and economical sizing of pipeline systems. The functions of surge chambers are investigated in the light of three aspects, i.e., (i) water-hammer pressure wave transmission; (ii) stability behaviour of surge oscillations; and (iii) energy relationship of flow under transient state. Experiments and analytical studies were made to examine pressure wave transmission. Compared with the Johnson differential chamber, both the change in its orifice position and local expansion of its riser play significant roles in reduction of the transmission. In most cases, the former has a more pronounced effect than the latter. Different turbine governing modes result in different degrees of stability. A combination of constant power and constant gate opening is applied to a surge chamber shared by two or more turbines. Compared with the case of constant power only, the common chamber requires a smaller cross-section for the stabilization of small-amplitude surges. The Liapunov stability theory provides a direct and qualitative procedure for judging the stability of non-linear surge oscillations. The Liapunov function represents the total specific energy of the system with surge tank. The conditions of existence of the function lead to criteria of asymptotic stability for the system. Mathematical manipulation of the differential equations governing water hammer provides an energy equation for the system with surge chamber. The equation states the relationship between the total energy, the convective energy, the work done on the system and the frictional energy dissipation. The energy approach sheds light upon the behaviour of transient flow in pipelines. 99 refs, 13 figs

1305 Economic, Industrial and Business Aspects

Refer also to citation(s) 6426, 6463

1306 Environmental Aspects

Refer also to citation(s) 6461

6463 (ANL/EAD/TM–1) **Class 1 overview of cultural resources for the Western Area Power Administration Salt Lake City Area Integrated Projects electric power marketing environmental impact statement.** Moeller, K.L.; Malinowski, L.M.; Hoffecker, J.F.; Walitschek, D.A.; Shogren, L.; Mathews, J.E.; Verhaaren, B.T. Argonne National Lab., IL (United States). Nov 1993. 113p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94005195. Source: OSTI; NTIS; GPO Dep.

Argonne National Laboratory conducted an inventory of known archaeological and historic sites in areas that could be affected by the hydropower operation alternatives under analysis in the power marketing environmental impact statement for the Western Area Power Administration's Salt Lake City Area Integrated Projects. The study areas included portions of the Green River (Flaming Gorge Dam to Cub Creek) in Utah and Colorado and the Gunnison River (Blue Mesa Reservoir to Crystal Dam) in Colorado. All previous archaeological surveys and previously recorded prehistoric and historic sites, structures, and features were inventoried and plotted on maps (only survey area maps are included in this report). The surveys were classified by their level of intensity, and the sites were classified according to their age, type, and contents. These data (presented here in tabular form) permit a general assessment of the character and distribution of archaeological remains in the study areas, as well as an indication of the sampling basis for such an assessment. To provide an adequate context for the descriptions of the archaeological and historic sites, this report also presents overviews of the environmental setting and the regional prehistory, history, and ethnography for each study area.

14 SOLAR ENERGY

Refer also to citation(s) 6329

6464 (CONF-9310251–Summ.) **Interagency Advanced Power Group, Solar Working Group: Meeting minutes.** Horizon Data Corp., Reston, VA (United States). Power Information Center. 14 Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC01-90CE90053. From Interagency Advanced Power Group (IAPG) solar working group meeting; Denver, CO (United States); 18 Oct 1993. Order Number DE94004953. Source: OSTI; NTIS; GPO Dep.

This report is the minutes of the Solar Working group. The meeting was prompted by the Steering Group's desire to resolve issues the Solar Working Group.

6465 (SP–93-36) **Solar energy in China.** Wennerholm, H. Swedish National Testing and Research Inst., Boraas (Sweden). 1993. 36p. Order Number DE94730452. Source: OSTI; NTIS.

The report presents the progress, status and goals of the Chinese national solar energy programmes since 1970s. It applies specially to solar water heating, solar drying, passive solar, solar cookers, and solar photovoltaics. In China, an expertise team has been organized, a number of technology development centers for new and renewable sources of energy have been set up and some demonstration projects are under way. Since 1970s Chinese Government has paid much attention to research, development and utilization of new and renewable sources of energy (NRSE). A coherent strategy governing the R and D and utilization of NRSE has been pursued for planners and descisionmakers. It is stated as 'planning in accordance with local resources available and economic conditions; multienergy complementary supply; integrated use and concern of commercial and economic viability'. Chinas population is so large that it accounts for one fifth of the worlds total. Despite its vigorous family planning efforts, the absolute population growth would still be considerable due to its enormous population base line. This can not but affect the future of the whole mankind. Shortage of energy in China can not be expected to be overcome in a short period of time. The only way out is to adopt various kinds of energy conservation measures and increase the utilization of NRSE, while expanding the production of conventional energy. 16 refs, 11 figs, 10 tabs

1401 Resources and Availability

Refer also to citation(s) 6480

1403 Economic, Industrial, and Business Aspects

Refer also to citation(s) 6426, 6478

1405 Solar Energy Conversion

Refer also to citation(s) 6479, 6481, 7052

6466 (DOE/FTR–94000750) **Travel to Hungary to participate in the International Solar Energy Society Solar World Congress 1993: Foreign trip report, August 19, 1993–September 3, 1993.** Surek, T. National Renewable Energy Lab., Golden, CO (United States). 3 Oct 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000750. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report covers my foreign travel to Austria, Hungary, Spain, and England from August 19–September 3, 1993. Following a weekend stopover in Austria, I attended the ISES Solar World Congress 1993 in Budapest, Hungary. I was part of a three-member DOE delegation at the ISES meeting, where I presented an invited review of photovoltaic research activities in the United States and co-chaired two sessions. The report covers the technical highlights of the conference and the technical exhibit. Several workshops were held concurrently with the ISES meeting. Many of these dealt with renewable energy policies, programs, business, and financing. Several proposals resulted from these meetings dealing with international collaborations in renewable energy and initiatives with developing countries. The major market thrusts of photovoltaic companies in Europe are toward developing countries and domestic applications in residential and commercial buildings. The visits to the Universidad Politecnica de Madrid and BP Solar Espana provided me with an opportunity to gain information on one of the leading research laboratories in Europe in crystalline silicon solar cells and one of the world leaders in crystalline silicon module manufacturing. BP Solar, in fact, produces the highest efficiency commercial silicon modules. The visit to Crystalox provided a better understanding of a leading manufacturer of silicon ingot growth equipment. The details of my findings are described in the report. The reference list contains various materials (preprints, technical literature, etc.) from the ISES meeting and the visits. Copies of these materials are available on request.

6467 (ECN-RX–93-099) **Hydrogen and deuterium in multicrystalline silicon wafers and solar cells.** Weeber, A.W. (Netherlands Energy Research Foundation ECN, Petten (Netherlands)); De Moor, H.H.C.; Steeman, R.A.; Sinke, W.C.; Schuurmans, F.M.; Michiels, P.P.; Verhoef, L.A.; Alkemade, P.F.A.; Algra, E. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Sep 1993. 2p. Contract NOVEM 41.220-026.1; Project ECN 4413. Order Number DE94729850. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

Paper presented at the 7th International Photovoltaic Science and Engineering Conference, Nagoya, Japan, November 22-26, 1993; This work is carried out within the framework of the NOVEM National Research Programme Solar Energy-Photovoltaics and the ECN programme ENGINE.

Hydrogen and deuterium plasma treatments were performed on the front side of p-type multi-crystalline silicon wafers with and without emitter, and of solar cells. These treatments were performed at temperatures around 150°C and 250°C for 15 to 90 minutes. Chemical depth profiling of deuterium and electrical profiling of hydrogen and deuterium were carried out using SIMS. To correlate the concentration of hydrogen and deuterium to the effect of passivation, this concentration, the minority carrier diffusion length and changes in the cell parameters are compared. 2 figs., 1 tabs., 6 refs.

6468 (ECN-RX–93-100) **Hydrogen and deuterium in semicrystalline silicon wafers and solar cells.** Weeber, A.W. (Netherlands Energy Research Foundation ECN, Petten (Netherlands)); De Moor, H.H.C.; Steeman, R.A.; Sinke, W.C.; Schuurmans, F.M.; Michiels, P.P.; Verhoef, L.A. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Sep 1993. 6p. Contract NOVEM 41.220-026.1; Project ECN 4413. Order Number DE94729849. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

Paper presented at the Polycrystalline Semiconductors Physics and Technology Conference (POLYSE '93), St. Malo, France, September 5-10, 1993; This work is carried out within the framework of the NOVEM National Research Programme Solar Energy-Photovoltaics and the ECN programme ENGINE.

Hydrogen and deuterium plasma treatments were performed on the front side of p-type semi-crystalline silicon wafers with and without emitter, and of solar cells. These treatments were performed at temperatures around 150°C and 250°C for 15 to 90 minutes. Chemical depth profiling of deuterium and electrical profiling of hydrogen and deuterium were carried out using SIMS and the C-V profiling technique. To correlate the concentration of hydrogen and deuterium to the effect of passivation, this concentration, the minority carrier diffusion length and changes in the cell parameters are compared. 2 figs., 3 tabs., 8 refs.

6469 (NREL/CP–410-6033) **Photovoltaic performance and reliability workshop.** Mrig, L. (ed.). National Renewable Energy Lab., Golden, CO (United States). [1993]. 504p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. (CONF-9309188–: Photovoltaic performance and reliability workshop, Golden, CO (United States), 8-10 Sep 1993). Order Number DE94000236. Source: OSTI; NTIS; GPO Dep.

This workshop was the sixth in a series of workshops sponsored by NREL/DOE under the general subject of photovoltaic testing and reliability during the period 1986–1993. PV performance and PV reliability are at least as important as PV cost, if not more. In the US, PV manufacturers, DOE laboratories, electric utilities, and others are engaged in the photovoltaic reliability research and testing. This group of researchers and others interested in the field were brought together to exchange the technical knowledge and field experience as related to current information in this evolving field of PV reliability. The papers presented here reflect this effort since the last workshop held in September, 1992. The topics covered include: cell and module characterization, module and system testing, durability and reliability, system field experience, and standards and codes.

6470 (NREL/TP–411-5800) **Semiannual technical progress report: Advanced development of PV encapsulants: Annual subcontract report, 1 January 1993–30 June 1993.** Holley, W.H. (Springborn Labs., Inc., Enfield, CT (United States)). National Renewable Energy Lab., Golden, CO (United States); Springborn Labs., Inc., Enfield, CT (United States). Dec 1993. 67p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000219. Source: OSTI; NTIS; GPO Dep.

This report describes the results of the literature search, interviews, and site visits conducted during the first six months of this subcontract. This survey was conducted to establish a baseline of information about thermal and photothermal degradation of EVA and case history surveys on discoloration (yellowing/browning) of EVA-based encapsulants in fielded flat-plate PV modules. The literature search revealed that EVA will undergo thermolysis of the acetate groups at temperatures of 130°C to 150°C and above, leading to formation of double bonds in the backbone of the copolymer. The survey of case histories of EVA-based encapsulant discoloration in fielded modules in the United States revealed that the problem is limited to those areas of the west and southwest that have comparatively high solar insolation and ambient temperature. It is clear that the discoloration problem is not limited to the modules of any one manufacturer. Discoloration in the EVA encapsulant was experienced in fielded modules from all major US module producers.

6471 (NREL/TP–411-6003) **Continuous roll-to-roll a-Si photovoltaic manufacturing technology: Annual subcontractor report, 1 April 1992–31 March 1993.** Izu, M. (Energy Conversion Devices, Inc., Troy, MI (United States)). National Renewable Energy Lab., Golden, CO (United States); Energy Conversion Devices, Inc., Troy, MI (United States). Dec 1993. 84p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000260. Source: OSTI; NTIS; GPO Dep.

This report describes work done under a 3-year program to advance ECD's roll-to-roll, triple-junction photovoltaic manufacturing technologies, to reduce the module production costs, to increase the stabilized module performance, and to expand commercial capacity utilizing ECD technology. The specific 3-year goal is to develop advanced large-scale manufacturing technology incorporating ECD's earlier research advances with the capability of producing modules with stable 11% efficiency at a cost of approximately $1.00 per peak watt. Accomplishments during Phase 1 included: (1) ECD successfully incorporated a high-performance Ag/metal-oxide back-reflector system into its continuous roll-to-roll commercial production operation. (2) High-quality a-Si-Ge narrow-band-gap solar cells were incorporated into the manufacturing. (3) ECD demonstrated the continuous roll-to-roll production of high-efficiency, triple-junction, two-band-gap solar cells consistently and uniformly throughout a 762-m (2500-ft) run with high yield. (4) ECD achieved 11.1% initial sub-cell efficiency of triple-junction, two-band-gap a-Si alloy solar cells in the production line. (5) The world's first 0.37-m^2 (4-ft^2) PV modules were produced utilizing triple-junction spectrum-splitting solar cells manufactured in the production line. (6) As a result of process optimization to reduce the layer thickness and to improve the gas utilization, ECD achieved a 77% material cost reduction for germane and 58% reduction for disilane. Additionally, ECD developed a new low-cost module that saves approximately 30% in assembly material costs.

6472 (NREL/TP–411-6010) **PV Cz silicon manufacturing technology improvements: Annual subcontract report, 1 April 1992–31 March 1993.** Jester, T. (Siemens Solar Industries, Camarillo, CA (United States)). National Renewable Energy Lab., Golden, CO (United States); Siemens Solar Industries, Camarillo, CA (United States). Jan 1994. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000248. Source: OSTI; NTIS; GPO Dep.

This report describes work performed under a 3-year contract to demonstrate significant cost reductions and improvements in manufacturing technology. The work focused on near-term projects for implementation in the Siemens Solar Industries Czochralski (Cz) manufacturing facility in Camarillo, California. The work was undertaken to increase the commercial viability and volume of photovoltaic manufacturing by evaluating the most significant cost categories and then lowering the cost of each item through experimentation, materials refinement, and better industrial engineering. The initial phase of the program concentrated on the areas of crystal growth; wafer technology; and environmental, safety, and health issues.

6473 (NREL/TP–411-6046) **Thin EFG octagons: Annual subcontract report, 1 April 1992–31 March 1993.** Kalejs, J.P. (Mobil Solar Energy Corp., Billerica, MA (United States)). National Renewable Energy Lab., Golden, CO (United States); Mobil Solar Energy Corp., Billerica, MA (United States). Jan 1994. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000257. Source: OSTI; NTIS; GPO Dep.

Mobil Solar Energy Corporation currently practices a unique crystal growth technology for producing crystalline silicon sheet, which is then cut with lasers into wafers. The wafers are processed into solar cells and incorporated into modules for photovoltaic applications. The silicon sheet is produced using a method known as Edge-defined Film-fed growth (EFG), in the form of hollow eight-sided polygons (octagons) with 10 cm faces. These are grown to lengths of 5 meters and thickness of 300 microns, with continuous melt replenishment, in compact furnaces designed to operate at a high sheet area production area of 135 cm^2/min. The present Photovoltaic Manufacturing Technology (PVMaT) three-year program seeks to advance the manufacturing line capabilities of the Mobil Solar crystal growth and cutting technologies. If successful, these advancements will provide significant reductions in already low silicon raw material usage, improve process productivity, laser cutting throughput and yield, and so lower both individual wafer cost and the cost of module production. This report summarizes the significant technical improvements in EFG technology achieved in Phase 1 of this program. Technical results are reported for each of the three main program areas: (1) thin octagon growth (crystal growth) – to reduce the thickness of the octagon to an interim goal of 250 microns during Phase 1, with an ultimate goal of achieving 200 micron thicknesses; (2) laser cutting – to improve the laser cutting process, so as to produce wafers with decreased laser cutting damage at increased wafer throughput rates; and (3) process control and product specification – to implement advanced strategies in crystal growth process control and productivity designed to increase wafer yields.

6474 (NREL/TP–411-6047) **Large-area triple-junction a-Si alloy production scale up: Annual subcontract report, 17 March 1992–18 March 1993.** Oswald, R. (Solarex Corp., Newtown, PA (United States). Thin Film Division); O'Dowd, J. National Renewable Energy Lab., Golden, CO (United States); Solarex Corp., Newtown, PA (United States). Thin Film Div. Jan 1994. 51p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000249. Source: OSTI; NTIS; GPO Dep.

The objective of this subcontract over its three-year duration is to advance Solarex's photovoltaic manufacturing technologies, reduce its a-Si:H module production costs, increase module performance and expand the Solarex commercial production capacity. Solarex shall meet these objectives by improving the deposition and quality of the transparent front contact; optimizing the laser patterning process; scaling up the semiconductor deposition process; improving the back contact deposition; and scaling up and improving the encapsulation and testing of its a-Si:H modules. In the Phase 1 portion of this subcontract Solarex focused on scaling up components of the chemical vapor deposition system for deposition of the front contact, scaling up laser scribing techniques; triple-junction recipes for module production; and metal oxide back contacts. These efforts resulted in adopting portions of the manufacturing line to handle substrates larger than 0.37 m^2.

6475 (NREL/TP–411-6110) **Silicon-Film™ photovoltaic manufacturing technology: Semiannual subcontract report, 15 November 1992–15 May 1993.** Bottenberg, W.R. (AstroPower, Inc., Newark, DE (United States)). National Renewable Energy Lab., Golden, CO (United States); AstroPower, Inc., Newark, DE (United States). Jan 1994. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000258. Source: OSTI; NTIS; GPO Dep.

AstroPower is in the second phase of a 3-year, phased effort to upgrade its facility to produce 1.22-m^2 Silicon-Film™ PV modules with an output of 170 W_p. Productivity improvements of the Silicon-Film™ machine were accomplished during the second phase. Improvements were made in solar cell performance while decreasing materials consumption, integrating and mechanizing the fabrication process for solar cells, and scaling-up solar cell and module equipment for fabricating larger cells. AstroPower is continuing work on separating out effects due to impurities and effects due to defects. Analytical tools were developed for measuring area-based response based on EBIC and LBIC methods. The Kauffman source for hydrogen ion implantation was used to map out the process space for Silicon-Film™ solar cell improvement. Progress was made on improving short-circuit current. Areas of focus include developing tools to quickly assess material quality; developing a hydrogen implantation process; increasing material quality on large-area, high-throughput wafers; and studying potential processes for improving solar cell power output during cell fabrication. A method to improve current collection in a solar cell after contact formation is under development.

6476 (NREL/TP–413-6216) **Research on high-efficiency, large-area, $CuInSe_2$-based thin- film modules: Annual subcontract report, 1 May 1992–15 Aug 1993.** Knapp, K.E. (Siemens Solar Industries, Camarillo, CA (United States)); Gay, R.R. National Renewable Energy Lab., Golden, CO (United States); Siemens Solar Industries, Camarillo, CA (United States). Jan 1994. 39p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000259. Source: OSTI; NTIS; GPO Dep.

This report describes work to demonstrate 12.5% aperture efficient, large-area (3900-cm^2) encapsulated thin-film $CuInSe_2$ (CIS) photovoltaic modules. Module design consists of 53 series-connected ZnO/CdS/CIS/Mo/glass cells fabricated on a 4141-cm^2 (128.6 x 32.2 cm) glass substrate with a nominal aperture area of 3895 cm^2 (127.3 x 30.6 cm). Four CIS modules were shipped to NREL under the terms of the subcontract. Phase 2 consisted of fabricating large-area (3900-cm^2) modules for high-performance module processing. The large-area parts proved to be cumbersome, and we decided to use smaller substrates (100 cm^2) to accelerate the progress in solving the types of technical challenges that were discovered in processing large-area parts, and then to apply these solutions to larger areas to meet the objectives of the investigation. Most critical issues determining module yield losses can be grouped into three major categories: (1) Uniformity and reproducibility of the absorber formation process dominates the fundamental performance of the material over a large area, (2) interaction of the substrate with the Mm requires appropriate selection criterial and preparation techniques for minimizing defects that lead to shunting and areas of poor photoresponse, and (3) performance losses near interconnects reduce module performance and can cause inadequate performance through module durability testing.

6477 (NREL/TP–451-5746) **High-efficiency, thin-film solar cells: Annual subcontractor report, 1 July 1991–30 June 1992.** Gale, R.P. (Kopin Corp., Taunton, MA (United States)). National Renewable Energy Lab., Golden, CO (United States); Kopin Corp., Taunton, MA (United States). Jan 1994. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000250. Source: OSTI; NTIS; GPO Dep.

This report describes work on a 3-year research program to investigate thin-film GaAs/GaInP cells using the cleavage of lateral epitaxial film for transfer (CLEFT) technique, and to determine the process to enable overgrowth of GaAs films using organometallic chemistry. Application of the CLEFT thin-film technique to GaInP/GaAs solar cells and organometallic overgrowth was investigated. A problem of alloy contamination was identified and controlled, leading to higher quality layers. Solar cell structures were grown and fabricated using previously determined growth parameters for GaAs and GaInP. With the improved materials developed significant improvements were made in solar cell performance. Conditions for in-situ overgrowth by organometallic chemical vapor deposition (OMCVD) were determined and continuous GaAs layers were grown over a separation mask layer. The layers were successfully separated from their substrate using the CLEFT process, demonstrating the application of overgrowth using OM chemistry with HCl.

6478 (SAND–93-7098) **Performance of the Southern California Edison Company Stirling dish.** Lopez, C.W. (Southern California Edison Co., Rosemead, CA (United States)); Stone, K.W. Sandia National Labs., Albuquerque, NM (United States); Southern California Edison Co., Rosemead, CA (United States); Mako Enterprises, Huntington Beach, CA (United States). Oct 1993. 211p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94004676. Source: OSTI; NTIS; GPO Dep.

McDonnell Douglas Astronautics Company (MDAC) and United Stirling AB of Sweden (USAB) formed a joint venture in 1982 to develop and produce a Stirling dish solar generating system. In this report, the six year development and testing program continued by the Southern California Edison Company (SCE) is described. Each Stirling dish module consists of a sun tracking dish concentrator developed by the MDAC and a Stirling engine driven power conversion unit (PCU) developed by USAB. The Stirling dish system demonstrated twice the peak and daily solar-to-electric conversion efficiency of any other system then under development. This system continues to set the performance standard for solar to electric systems being developed in the early 1990's. Test data are presented and used to estimate the performance of a commercial system.

1406 Photovoltaic Power Systems

Refer also to citation(s) 6478

6479 (DOE/FTR–94004453) **Travel to Japan to evaluate photovoltaic developments in Japan, Australia, and Europe: Foreign trip report, November 16–26, 1993.** Basore, P.A. Sandia National Labs., Albuquerque, NM (United States). 9 Dec 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94004453. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The 7th International Photovoltaic Science and Engineering conference (PVSEC) is one of three major international conferences on photovoltaic technology; it is held approximately every 18 months. Of the 524 attending this year's conference in Nagoya, 391 were from Japan. The 6th Sunshine Workshop on Crystalline-Silicon Solar Cells was held in Tokyo the week before PVSEC to provide a forum for in-depth discussion of this particular topic among 40 of the world's leading researchers in this area. Paul Basore presented Sandia's one-step phosphorus diffusion process for simplifying the fabrication of high-efficiency silicon solar cells, he outlined the DOE program supporting crystalline-silicon PV technology, he chaired a session on crystalline silicon, and he participated in a panel discussion on factors affecting surface recombination in silicon. With retail electricity costs more than double those in the US, grid-tied residential systems based on crystalline silicon will become economically viable in Japan long before they reach a similar status in the US. Consequently, crystalline-silicon technology is given greater emphasis in Japan than here. This trip provided an excellent opportunity to assess progress in this important technology.

6480 (ENEA-RT-ENERG–92-01) **Room temperature effect in siting flat plate photovoltaic systems.** Barra, L. (ENEA, Casaccia (Italy). Area Energetica); Coiante, D. No corporate text available. Mar 1993. 31p. (RT/ENERG–92-01). Order Number DE94727310. Source: OSTI; NTIS (US Sales Only).

In the present paper a method to evaluate the room temperature effect in deteriorating the performance of Silicon flat plate PV systems is investigated. The calculations, applied to crystalline Silicon arrays, show a significant energy loss with respect to reference temperature conditions, specially in correspondence to the sites with highest insolation, in which the effect can amount up to about 15%. As a consequence, the previous projections about kWh cost for large scale PV power stations should be rectified by introducing a correction factor accounting for thermal effects. The calculations were carried out for 64 zones, particularly suitable for siting PV plants and distributed among 15 Countries over a latitude belt ranging from about 40 North to 15 South. For each zone, it was accounted both for room temperature and insolation historical data. The final results show a linear correlation between yearly global sun radiation density and room temperature effect, which appears quite general, so that, for any other site within the latitude belt, it is possible to account for thermal effect on PV kWh cost simply by knowing the global sun radiation density on horizontal surface (usually the only experimental available datum).

6481 (Juel–2736) **Construction of a computer-assisted experimental facility for recording the voltage-current characteristic of amorphous solar modules.** Mueck, A. Forschungszentrum Juelich GmbH (Germany). Inst. fuer Schicht- und Ionentechnik. Feb 1993. 80p. (In German). Order Number DE94734006. Source: OSTI; NTIS (US Sales Only).

An experimental facility for amorphous solar models was constructed. The measuring system was to be computer-assisted, with a modular data acquisition and control system. Programming was done in Quick Basic 4.5 on an IBM-compatible 386 AT unit. (HW)

1407 Solar Thermal Power Systems

6482 (CONF-9305134–, pp. 172-179) **Radiative transfer through arrays of discrete surfaces.** Welty, J.R. (Oregon State Univ., Corvallis, OR (United States)); Zaworski, J.R.; Drost, M.K. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis,*

measurement and characterization. 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Radiant transport involving arrays of discrete surfaces constitutes one of the major unresolved problems in the field of radiation heat transfer. This paper discusses the requirements for experimental validation of a general Monte Carlo solution to this class of problems. This work is a collaborative effort between Oregon State University, where the experimental portion is being accomplished, and the Pacific Northwest Laboratory, which is responsible for the Monte Carlo simulation. The design and calibration of a simple, compact, and flexible instrument for direct measurement of bidirectional reflectance are presented in some detail. The capability to measure full bidirectional reflectance, as provided by this instrument, is essential to an accurate portrayal of surface properties in a Monte Carlo simulation. Measured data for a common flat white paint are presented and clearly demonstrate the need for accurate and complete surface property information. Applications include volumetric air heating solar central receivers, ceramic fabrics, and fibrous insulation.

6483 (CONF-9305134–, pp. 180-187) **Aspects of radiation heat transfer in arrays of fixed discrete surfaces.** Drost, M.K. (Pacific Northwest Lab., Richland, WA (United States)); Palmer, B.J.; Welty, J.R. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Arrays of fixed discrete surfaces are encountered in a number of important applications. Evaluating radiant heat transfer in an array of fixed discrete surfaces is challenging because array optical properties are often nonhomogeneous and anisotropic. This article presents the results of a Monte Carlo simulation of radiation heat transfer in several array geometries. The results show that for the array geometries included in the study, the extinction coefficient is strongly anisotropic and that optical properties are dependent on both the geometric arrangement of the elements and the scattering characteristics of individual elements. Applications include volumetric air heating solar central receivers, ceramic fabrics, and fibrous insulation.

6484 (PNL-SA–21757) **Aspects of radiation heat transfer in arrays of fixed discrete surfaces.** Drost, M.K. (Pacific Northwest Lab., Richland, WA (United States)); Palmer, B.J.; Welty, J.R. Pacific Northwest Lab., Richland, WA (United States). Aug 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930830–32: National conference and exposition on heat transfer, Atlanta, GA (United States), 8-11 Aug 1993). Order Number DE94003727. Source: OSTI; NTIS; GPO Dep.

Arrays of fixed discrete surfaces are encountered in a number of important applications. Evaluating radiant heat transfer in an array of fixed discrete surfaces is challenging because array optical properties are often nonhomogeneous and anisotropic. This article presents the results of a Monte Carlo simulation of radiation heat transfer in several array geometries. The results show that for the array geometries included in the study, the extinction coefficient is strongly anisotropic and that optical properties are dependent on both the geometric arrangement of the elements and the scattering characteristics of individual elements.

6485 (SAND–93-2504C) **Concepts to measure flux and temperature for external central receivers.** Pacheco, J.E. (Sandia National Labs., Albuquerque, NM (United States)); Houser, R.M.; Neumann, A. Sandia National Labs., Albuquerque, NM (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940326–3: American Society of Mechanical Engineers (ASME) international solar energy conference, San Francisco, CA (United States), 27-30 Mar 1994). Order Number DE94003713. Source: OSTI; NTIS; GPO Dep.

Three concepts to measure incident flux (1) relative, real-time power measurement, (2) flux mapping and incident power measurement, and (3) real-time flux mapping) and two concepts to measure receiver surface temperatures low and high resolution temperature measurements) on an external central receiver are discussed along with the potential and shortcomings of these concepts to make the desired measurements and the uncertainties associated with the measurements caused by atmospheric and surface property variations. These concepts can aid in the operation and evaluation of the receiver and plant. Tests have shown that the incident flux distribution on a surface can be mapped out using a fixed, narrow white target and a CCD camera system by recording the images of the beam as it is passed over the target and by building a composite image. Tests with the infrared cameras have shown they are extremely valuable tools in determining temperature profiles during startup of the receiver and throughout operation. This paper describes each concept in detail along with the status of testing to determine the feasibility of these concepts.

1409 Solar Thermal Utilization

Refer also to citation(s) 6845, 6846, 6850, 7003

6486 (LBL–34876) **Evaluation of solar gain through skylights for inclusion in the SP53 residential building loads data base.** Hanford, J.W.; Huang, Y.J. Lawrence Berkeley Lab., CA (United States). Dec 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94004940. Source: OSTI; NTIS; GPO Dep.

The energy performance of skylights is similar to that of windows in admitting solar heat gain, while at the same time providing a pathway for convective and conductive heat transfer through the building envelope. Since skylights are typically installed at angles ranging from 0° to 45°, and differ from windows in both their construction and operation, their conductive and convective heat gains or losses, as well as solar heat gain, will differ for the same rough opening and thermal characteristics. The objective of this work is to quantify the impact of solar gain through skylights on building heating and cooling loads in 45 climates, and to develop a method for including these data into the SP53 residential loads data base previously developed by LBL in support of DOE's Automated Residential Energy Standard (ARES) program. The authors used the DOE-2.1C program to simulate the heating and cooling loads of a prototypical residential building while varying the size and solar characteristics of skylights and windows. The results are presented as Skylight Solar Loads, which are the contribution of solar gains through skylights to the overall building heating and cooling loads, and as Skylight Solar Load Ratios, which are the ratios of skylight solar loads to those for windows with the same orientation. The study shows that skylight solar loads are larger than those for windows in both heating and cooling. Skylight solar cooling loads are from three to four times greater than those for windows regardless of the skylight tilt, except for those facing north. These cooling loads are largest for south-facing skylights at a tilt angle of approximately 20°, and drop off at higher tilts and other orientations.

6487 (NEI-DK–1365) **Pilot project for solar house Egebjerggaard.** Moerck, O. Cenergia ApS, Ballerup (Denmark). Jun 1993. 36p. (In Danish). Contract ENS-51191-92.0034. Order Number DE94730345. Source: OSTI; NTIS.

The aim was to plan and commence technical investigations and further develop the architectural aspects of a project dealing with larger low-energy buildings, using solar energy, which could be used as examples for future building constructions of this kind. These processes are very briefly described. The technological investigations include glass types used in ventilation windows, utilization of daylighting, heating and ventilation systems, thermal simulations, environmental considerations, choice of materials and water saving. A comparatively voluminous appendix includes a number of architectural drawings related to the development at Egebjerggard. (AB)

1410 Solar Collectors and Concentrators

6488 (CONF-9305134–, pp. 188-196) **Nonimaging reflectors as functionals of the desired irradiance.** Winston, R. (Univ. of Chicago, IL (United States)); Ries, H. Argonne National Lab., IL (United States). 1993. DOE Contract FG02-87ER13726. From 11. symposium on energy engineering sciences; Argonne, IL (United

States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

For many tasks in illumination and collection the acceptance angle is required to vary along the reflector. If the acceptance angle function is known, then the reflector profile can be calculated as a functional of it. The total flux seen by an observer from a source of uniform brightness (radiance) is proportional to the sum of the view factor of the source and its reflection. This allows one to calculate the acceptance angle function necessary to produce a certain flux distribution and thereby construct the reflector profile. The authors demonstrate the method for several examples, including finite size sources with reflectors directly joining the source.

6489 (NEI-DK–1363) **Development of solar air heaters.** Svendsen, S. (Danmarks Tekniske Hoejskole. Laboratoriet for Varmeisolering, Lyngby (Denmark)); Schioeler, C.; Pedersen, L.; Moerck, O.; Kofod, P. Cenergia ApS, Ballerup (Denmark). Jun 1993. 78p. (In Danish). Contract ENS-51181-92.0033. Order Number DE94730344. Source: OSTI; NTIS.

The development of the design for a new type of solar air heater (a type of solar collector based on air as the medium for heat transfer) which could compete with solar collectors based on liquids is described in detail. The advantages of this system are that the design is simple and cheap, there are no risks in relation to frost, boiling or damage to buildings by leakage and it is suitable for use as a low temperature source for low temperature buildings. The system has a longer service life and needs less maintenance. Information was derived largely from sources outside of Denmark and an evaluation of commercial products, thermal theories, materials, laboratory tests etc. It is concluded that the efficiency of solar collectors based on air and those based on liquids is about the same. Air-based systems are especially suitable for direct space heating at low temperatures and can be integrated as a facade component, in which case their use must be taken into consideration at the architectural planning stage. This type of solar collector could also be used to collect waste heat from industrial processes, for preheating ventilation air and in closed systems where heat exchangers are used for exchange to hot water. Leakage must be avoided to minimize electricity consumption related to ventilators. Standard components are recommended for these systems. Air based solar collectors would be suitable for glass structures. (AB)

6490 (NEI-DK–1369) **Solar collector constructed of welded plastic foils.** Bach Thomassen, F. Dansk Teknologisk Inst., Aarhus (Denmark). Aug 1993. 14p. (In Danish). Contract ENS-51181-93.0012. Order Number DE94730347. Source: OSTI; NTIS.

The aim was to construct a solar collector of welded plastic foils which, it was reckoned, would be cheaper to produce than those currently on the market. The solar collector consists of several layers of plastic foil welded together in a certain pattern. The layer which surrounds the water is made of black plastic which absorbs the solar light and the other layers are of clear plastic. The insulating layer can be blown up - which increases the insulating properties. Parts for in- and outlet of water and eyelets for fixing the solar collector can be added. Transport of this collector is very easy when the air is let out. It can be used on house roofs, in connection with swimming pools, camping areas and caravans etc., though in connection with larger areas of solar collectors its service life would be shorter and would have to be secured against extreme weather conditions. The design and choice of materials are further elaborated and the test results are given in detail. It is concluded that non-insulated solar collectors are only suitable to raise the temperature 5-6 degrees centigrade above the surrounding temperature. The water runs evenly through all the channels in the solar collector with parallel channels. The welding of the plastic materials must not present large piezometric surfaces as these can easily be torn. Such areas should be reinforced to achieve resistance to pressure in vulnerable places. (AB)

6491 (SAND–93-1533C) **Development of a 2f optical performance measurement system.** Grossman, J.W. Sandia National Labs., Albuquerque, NM (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940326–2: American Society of Mechanical Engineers (ASME) international solar energy conference, San Francisco, CA (United States), 27-30 Mar 1994). Order Number DE94003489. Source: OSTI; NTIS; GPO Dep.

Commercialization of faceted stretched-membrane concentrators has created the need for quality control measurements for facet optical performance. High-volume production scenarios require a test method that is quick, can be performed on the production floor, and does not require laboratory-grade equipment. At Sandia, we are developing an optical test method that can be done in a relatively short period of time, requires little space, uses "off the shelf" test equipment, and provides a quantitative measure adequate to address quality control requirements. The test method is based on common ray trace calculations for targets and images at the radius of curvature for spherical and parabolic (f/D > 3) concentrators. The initial development work was done using a monochrome television camera and the beam characterization system. Twenty-four 3-meter facets built for a faceted stretched-membrane dish were characterized using this system. Other smaller facets have also been tested with the system to help establish a correlation with this method and other optical characterization tests. Current work involves adapting a color camera to the system and developing custom software to reduce analysis time and make the system viable for the production floor. This paper discusses the development of the monochrome system, reviews the results of testing, and presents plans for the development of a color system.

6492 (SP–93-16) **Data bases and specifications for solar collector materials.** Wennerholm, H. Swedish National Testing and Research Inst., Boraas (Sweden). 1993. 45p. (In Swedish). Order Number DE94730450. Source: OSTI; NTIS.

Materials used in solar heating systems co-operate to absorb energy from the sun and convert it to thermal energy. These materials must perform their intended function both when first installed and after extended use. The environment in which these materials are exposed can cause degradation in their performance. Numerous problems with materials in solar energy systems have demonstrated the need for data to assess their performance and durability. This report describes a database of solar materials that provides basic material data for designers, manufacturers and researchers in solar energy. Within the framework of selecting materials for a higher benefit in solar energy applications the database provides performance data, outdoor exposure data based on figures from manufacturers and researchers. Four material categories were distinguished: metals, plastics, absorber coatings, and glazing materials, transparent insulation materials. The database is updated continously. 5 refs, 9 tabs

6493 (SP–93-17) **Quality and durability of solar collectors in Sweden: Convection barriers of FEP-film - damage investigation.** Wennerholm, H. Swedish National Testing and Research Inst., Boraas (Sweden). 1993. 104p. (In Swedish). Order Number DE94730451. Source: OSTI; NTIS.

Transparent or translucent insulation materials (TIMs) represent a new class of materials with a high potential for increasing the efficiency of solar thermal conversion systems. A large number of materials have been subjected to theoretical and experimental investigation. If all materials that suppress heat losses but are transparent to solar radiation, vacuum, certain gases, convection barriers, etc, can be regarded as TIMs. Exploratory field and laboratory studies of degraded FEP-film convection barriers in flat plane thermal solar collectors are described. The study related to collectors that had been operating in Sweden for periods of one year to ten years. Both physical, functional (thermal) and chemical aspects of degradation were considered. The report identifies the mistakes made so that they need not be repeated by the solar collector manufacturers in the future. 11 refs, 59 figs, 11 tabs

15 GEOTHERMAL ENERGY

Refer also to citation(s) 6329

6494 (CONF-930484–, pp. 201-202) **Closing remarks.** Kessler, R.R. (Department of Energy, Washington, DC (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div.

[1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmental Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This article is closing remarks made at the end of the program review. The author points out the sense of partnership felt in the participation of government, laboratory, and industrial partners in striving to develop this technology. Several of the key accomplishments in the intervening years are touched upon, and the fact that geothermal energy is becoming a more recognized energy resource is emphasized. The author acknowledges the efforts of many individuals whose efforts at different levels have aided the development and promotion of the industry.

1501 Resources and Availability

6495 (ETDE/JP-mf–94732332) **Fiscal 1991 geothermal development promotion survey: Report (35) on sampling/analysis of geothermal fluids (Mizuwake-Toge south area).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Feb 1993. 119p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE94732332. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The paper surveys the spouting of geothermal fluids in test boring wells, the well logging, and the status of geothermal fluids, as a part of the geothermal development promotion survey in the Mizuwake-Toge south area. In the spouting test of N3-MW-6 well, the 53rd swabbing led successfully to spouting. The spouting amounted to 3.6 tons/h in steam and geothermal water, but stopped spontaneously in 100 minutes. Results of the logging are hardly different between before and after the spouting indicating a maximum temperature of 200°C, barometric pressure of 75, and water levels of a 250-300m section. The geothermal water is a neutral Cl deep-area type. N2-MW-2 well spouted immediately after the 10th swabbing, indicating steam of 3 tons/h at the stable time, geothermal water of 7.3 tons/h, pH9, Cl of 1500ppm, and the total spouting time of 4029 minutes. The place where the geothermal fluid flows in is 635m deep, and when the well head pressure was 1.7-3.9 barometric pressure, the spouted fluid temperature was 199-198°C. The geothermal water is a Cl-HCO3 type. In both wells geothermal water is ground water originated from meteoric water which reacted with peripheral rocks by volcanic heating and was formed in the deep area. 9 refs., 30 figs., 39 tabs.

6496 (ETDE/JP-mf–94732333) **Fiscal 1990 geothermal development promotion surbvey.: Report on development of a geothermal reservoir evaluation method.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1992. 366p. (In Japanese). Order Number DE94732333. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The development of a geothermal reservoir evaluation method is mentioned for the purpose of reducing the risk of the geothermal development and drawing up an appropriate power generation plan. As for simulators, a geothermal reservoir simulator (SING-I,II) and a geothermal well two-phase simulator (WENG) are developed. For SING-II, made are evaluation of fracture effects in the pressure interference test, production predicting simulation using fracture models, development of a multicomponent gas-liquid two-phase simulator and a tracer simulation function. As to WENG, verification on fluids containing CO2 and survey on fluids containing NaCl are made. In the Mori area which is a model field, continued observation on reservoir pressure is conducted as well as temperature/pressure logging and chemical analysis of spouted fluids. By three-dimensional grid models of reservoirs, reappearance of natural conditions of temperature/pressure distribution and discharge into the ground surface can roughly be made, and history matching is tried to be made. Newly also in Oguni area, reappearance of natural conditions is simulated using SING-I. 13 refs., 189 figs., 46 tabs.

1502 Geology and Hydrology of Geothermal Systems

Refer also to citation(s) 6496, 6507, 7520

6497 (CONF-930484–, pp. 31-36) **Summary of the DOE-industry working-group activities at the Geysers Geothermal Field, California.** Wright, P.M. (Univ. of Utah Research Institute, Salt Lake City, UT (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. Contract AD-1703. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

After several productive meeting, the four Geysers working groups have recommended three projects to be carried out jointly by DOE and the industry. They are (1) continuous coring in reservoir rocks to obtain samples for subsequent analyses, (2) a three-year injection test at Unit 18, and (3) construction of a suite of field-wide maps showing such things as superheat and deuterium distribution to supplement similar maps on top of reservoir and isobars. Planning for these projects is underway, and they should begin in late 1993.

6498 (CONF-930484–, pp. 79-84) **Geology, alteration, and magmatic-hydrothermal history of The Geysers felsite – potential applications for exploration and development.** Hulen, J.B. (Univ. of Utah Research Institute, Salt Lake City, UT (United States)); Nielson, D.L. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. DOE Contract AC07-90ID12929. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

The "felsite" is a shallow, young, granitic intrusive body centrally located within and beneath. The Geysers steam field. The field and the felsite are coaxial, and hydrothermal alteration effected by hot-water dominated geothermal systems antedating the modern steam reservoir shows systematic vertical zonation with respect to the pluton. The research summarized in this communication was undertaken both to clarify the role of the pluton in reservoir evolution, and to characterize critical felsite-specific controls on the fields's deep porosity and permeability. The felsite comprises at least three major intrusive phases. Two are high-silica granites probably older than 1.3 Ma. The third is granodiorite (1 Ma), temporally and chemically equivalent to overlying extrusive dacites of the Clear Lake volcanic field. All three intrusive phases are too old to be heat sources for the modern steam field, but probably were the heat engines for the prior liquid-dominant systems. Younger, deeper magmatic heat sources are strongly implied for the current vapor-dominated regime. Porosity in the felsite is provided by: (1) Extensively mineralized fractures and breccias, probably of both tectonic and high-temperature hydrothermal origin; and (2) miarolitic cavities in the upper levels of the pluton. The latter could be analogous to calcite-dissolution cavities in overlying metagraywacke – they could serve as storage sites for the fields's liquid water reserves. Porosity in these fractures, breccias, and vugs in partially occluded by hydrothermal vein minerals deposited in prior hotwater-dominated systems –tourmaline, ferroaxinite, quartz, potassium feldspar, epidote, actinolite, prehnite, and many others. Such secondary mineralization conceptually could serve as an excellent exploration guide to potentially productive portions of the felsite beyond the field's present boundaries.

6499 (CONF-930484–, pp. 91-96) **Development of conceptual exploration models of geothermal systems.** Moore, J.N.

(Univ. of Utah Research Institue, Salt Lake City, UT (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. DOE Contract AC07-90ID12929. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This paper describes the results of petrologic and geochemical investigations being conducted at The University of Utah Research Institute of geothermal systems. The primary purpose of this work is to develop a set of conceptual models that describe the geochemical structure of geothermal systems in different geologic environments. These models will help the explorationist and developer to formulate more effective strategies for evaluating and developing new geothermal systems and for monitoring those already in production. The conceptual models that are being developed are based on the integration of chemical data from production wells and springs and the results of fluid inclusion, mineralogic, and isotopic measurements. In this paper, newly developed models for the high-temperature liquid-dominated geothermal system at Coso, California, and the vapor-dominated system at The Geysers, also located in California, are described.

6500 (ETDE/JP-mf–94732334) **Geothermal development promotion survey.: Outline of Oguni area survey report on the development of a geothermal reservoir evaluation method.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 228p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE94732334. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

To clarify validity of an evaluation method using reservoir simulators, an application survey is made in the Oguni area, Kumamoto Pref. The observation analysis continued since 1990 revealed that there is a wide high water-permeable zone in the reservoirs north of the area. Also, data on pressure interference tests performed by combining production well and injection well confirmed that there is a non-permeable zone which divides the reservoirs between south and north. The fluid geochemical analysis makes grasp of fluid flow tighter. It was found out that there is a possibility of more than one heat history in the area, from the distribution of two peaks of the fluid inclusion filling temperature. Reservoir models by the thermal water single-phase simulator agree well with the measured temperature/pressure. Steam-thermal water two-phase state concept models by the gas-liquid two-phase simulator are well correspondent to the measured shallow-area temperature/pressure interference test data. By these natural state reservoir models, the overall production predicting evaluation is made possible. Moreover, by fracture models, a behavior of fractured reservoirs can be quantitatively evaluated. 32 refs., 110 figs., 27 tabs.

6501 (LBL–34774) **Seismic monitoring at The Geysers.** Majer, E.L. (Lawrence Berkeley Lab., CA (United States)); Romero, A.; Vasco, D.; Kirkpatrick, A.; Peterson, J.E.; Zucca, J.J.; Hutchings, L.J.; Kasameyer, P.W. Lawrence Berkeley Lab., CA (United States); Lawrence Livermore National Lab., CA (United States). Apr 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098 ; W-7405-ENG-48. (CONF-930484–9: 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties, Berkeley, CA (United States), 27-29 Apr 1993). Order Number DE94003411. Source: OSTI; NTIS; GPO Dep.

During the last several years Lawrence Berkeley Laboratory (LBL) and Lawrence Livermore National Laboratory (LLNL) have been working with industry partners at The Geysers geothermal field to evaluate and develop methods for applying the results of microearthquake (MEQ) monitoring. It is a well know fact that seismicity at The Geysers is a common occurrence, however, there have been many studies and papers written on the origin and significance of the seismicity. The attitude toward MEQ data ranges from being nothing more than an curious artifact of the production activities, to being a critical tool in evaluating the reservoir performance. The purpose of the work undertaken b y LBL and LLNL is to evaluate the utility, as well as the methods and procedures used in of MEQ monitoring, recommend the most cost effective implementation of the methods, and if possible link physical processes and parameters to the generation of MEQ activity. To address the objectives above the MEQ work can be categorized into two types of studies. The first type is the direct analysis of the spatial and temporal distribution of MEQ activity and studying the nature of the source function relative to the physical or chemical processes causing the seismicity. The second broad area of study is imaging the reservoir/geothermal areas with the energy created by the MEQ activity and inferring the physical and/or chemical properties within the zone of imaging. The two types of studies have obvious overlap, and for a complete evaluation and development require high quality data from arrays of multicomponent stations. Much of the effort to date at The Geysers by both DOE and the producers has concentrated establishing a high quality data base. It is only within the last several years that this data base is being fully evaluated for the proper and cost effective use of MEQ activity. Presented here are the results to date of DOE's effort in the acquisition and analysis of the MEQ data.

1503 Geothermal Exploration and Exploration Technology

Refer also to citation(s) 6495, 6497, 6498, 6499, 6500, 6523, 6524, 6525, 6532, 7185

6502 (CONF-930484–, pp. 55-64) **Seismic monitoring at The Geysers.** Majer, E.L. (Lawrence Berkeley Lab., Berkeley, CA (United States)); Romero, A.; Vasco, D.; Kirkpatrick, A.; Peterson, J.E.; Zucca, J.J.; Hutchings, L.J.; Kasameyer, P.W. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. Contract W-7405-ENG-48. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

During the last several years Lawrence Berkeley Laboratory (LBL) and Lawrence Livermore National Laboratory (LLNL) have been working with industry partners at The Geysers geothermal field to evaluate and develop methods for applying the results of microearthquake (MEQ) monitoring. It is a well known fact that seismicity at The Geysers is a common occurrence, however, there have been many studies and papers written on the origin and significance of the seismicity. The attitude toward MEQ data ranges from being nothing more than a curious artifact of the production activities, to being a critical tool in evaluating the reservoir performance. The purpose of the work undertaken by LBL and LLNL is to evaluate the utility, as well as the methods and procedures used in MEQ monitoring, recommend the most cost effective implementation of the methods, and if possible link physical processes and parameters to the generation of MEQ activity. One of the most promising uses of MEQ monitoring that has been proposed is monitoring the flow of fluids during injection activities. Another proposed use has been to define active fault and fracture patterns that could be possible targets for in-fill drilling. A more recent use has been to use the microearthquakes as sources to image the physical properties within the reservoir area. The success of all of these proposed uses, as well as any other, will depend upon the resolution obtained and the understanding of the physical and chemical processes causing the MEQ activity. The use, or misuse, of MEQ data is critically dependent upon the quality and resolution of the data. In this sense The Geysers offers an excellent and unique test case due to the diversity of the studies carried out at The Geysers and the supporting geological, geophysical, hydrological, and geochemical information potentially available.

6503 (CONF-930484–, pp. 77) **Overview of exploration and reservoir characterization research – the reservoir technology program.** Renner, J.L. (Idaho National Engineering Lab., Idaho Falls, ID (United States)). USDOE Assistant Secretary for

Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. DOE Contract AC07-76ID01570. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

Reservoir Technology is a program of about 50 interrelated research projects. The research of the Reservoir Technology Program ranges from relatively pure research to applied cooperative work with the geothermal industry. Four types of research are carried out: basic research, applied research, cooperative research with industrial partners and research that is cost shared with industry. The Reservoir Technology Program's major interest is the answering of question posed by the industry. Although the basic research does not directly answer these questions, this research is providing fundamental data needed to properly understand the applied development problems of the industry. The geochemical research at Oak Ridge fits into this category. The fundamental research on volatility of HCl is one such project. The ORNL researches are providing fundamental chemical data which will be used to assist operators at The Geysers with control of corrosives in the steam. Other ORNL data is used to expand the chemical modeling efforts of John Weare at the University of California San Diego. The author describes other joint projects carried out either with industrial labs or with shared funding, and anticipates an increase in the number of such projects in the future.

6504 (CONF-930484–, pp. 111-112) **Memory logging tools.** Lysne, P. (Sandia National Laboratories, Albuquerque, NM (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

A suite of memory logging tools is being developed for slim-hole, high-temperature applications. The first tool will measure pressure and temperature, and it is especially designed to be a low-cost, but very precise, device. This tool will be smart in the sense that it can make "decisions" downhole. A second tool will measure the gamma-ray emissions from formation material, and it will be an indicator of lithology. A fluid sampling tool will complement the spectral gamma tool in that is will further constrain the lithology by identifying dissolved formation materials. Plans are being made to integrate the tool responses into formation parameters of interest through cooperative efforts between geothermal operators and scientific drilling programs.

6505 (CONF-930484–, pp. 113-114) **Slim-hole drilling for geothermal exploration.** Finger, J.T. (Sandia National Laboratories, Albuquerque, NM (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

Drilling production-size holes for geothermal exploration puts a large expense at the beginning of the project, and thus requires a long period of debt service before those costs can be recaptured from power sales. If a reservoir can be adequately defined and proved by drilling smaller, cheaper slim-holes, production well drilling can be delayed until the power plant is under construction, saving years of interest payments. In the broadest terms, this project's objective is to demonstrate that a geothermal reservoir can be identified and evaluated with data collected in slim holes. A coordinated working group, including personnel from Sandia, Lawrence Berkeley Lab, University of Utah Research Institute, US Geological Survey, independent consultants, and geothermal operators, has been assembled to focus on the development of this project. This group is involved to a greater or lesser extent in all decisions affecting the direction of the research. Specific tasks being pursued include: (1) Correlation of fluid flow and injection tests between slim-holes and production size wells. (2) Transfer of slim-hole exploration drilling and reservoir assessment to industry so that slim-hole drilling becomes an accepted method for geothermal exploration. (3) Development and validation of a coupled wellbore-reservoir flow simulator which can be used for reservoir evaluation from slim-hole flow data. (4) Collection of applicable data from commercial wells in existing geothermal fields. (5) Drilling of at least one new slim-hole and use it to evaluate a geothermal reservoir.

6506 (CONF-930484–, pp. 169-172) **Low-temperature resource assessment program.** Lienau, P.J. (Oregon Institute of Technology, Klamath Falls, OR (United States)); Ross, H. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. Contract C92-120253. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

In Fiscal Year 1991, Congress appropriated money for the Department of Energy to begin a new program in the evaluation and use of low- and moderate-temperature geothermal resources. The objective of this program is to promote accelerated development of these resources to offset fossil-fuel use and help improve the environment. The program will consist of several components, including: (1) compilation and characteristics, with emphasis on resources located within 8 km (5 miles) of population centers; (2) development and testing of techniques to discover and evaluate low- and moderate-temperature geothermal resources; (3) technical assistance to potential developers of low- and moderate-temperature geothermal resources; and (4) evaluation of the use of geothermal heat pumps in residential and commercial applications. Program participants will include the Geo-Heat Center at the Oregon Institute of Technology, the University of Utah Research Institute, the Idaho Water Resources Research Institute and agencies of state governments or Universities in most of the western states.

6507 (CONF-930484–, pp. 191-197) **1993 status report - The Bonneville Power Administration's geothermal program.** Darr, G.D. (Bonneville Power Administration, Portland, OR (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

The Bonneville Power Administration's (BPA) Geothermal Program includes up to three demonstration (pilot) power projects that will initiate development of high-potential reservoirs in the Pacific Northwest. The program also includes activities that support the pilot projects and that encourage the use of the region's geothermal resources. Activities supporting the pilot projects include initiating environmental baseline monitoring programs and conducting environmental and economic impact studies. Research activities include efforts to better understand the cold water blanket phenomenon in the Cascades, a study to characterize the hydrothermal system in the Pueblo Valley, a geothermal exploration program in southeastern Oregon, and support for research to expand the use of slim-holes for resource confirmation. Efforts to address institutional issues include support for the Regional Renewables Project, which will help Northwest environmentalists become more knowledgeable about the role of conservation and renewables in the region's energy picture. A guide to geothermal permitting and licensing was prepared to help developers and utilities find their way through the regulatory maze. A geothermal curriculum is being developed for grades 4 through 8 in the Oregon schools. Data on the location and operating experience of existing U.S. geothermal plants has been collected in a database. Market penetration of

geothermal heat pumps is being encouraged through a demonstration project in Montana and by helping BPA customers prepare proposals for geothermal heat pump projects that can compete successfully in BPA power acquisitions.

1504 Legislation and Regulations

Refer also to citation(s) 6506, 6512

6508 (CONF-930484–, pp. 1-9) **The office of energy efficiency and renewable energy: A policy overview.** Kessler, R.R. (Department of Energy, Washington, DC (United States)); Hoffman, A.R. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

Changes due to passage of the Energy Policy Act last fall and the new administration have resulted in much discussion about the 3E's; Energy, Environment, and Economic objectives. As part of these changes, the Office of Conservation and Renewable Energy has been renamed the Office of Energy Efficiency and Renewable Energy (EE). This paper discusses some of the new thrusts and directions of DOE brought about by the change in leadership. The new Energy Secretary has recently restructured the DOE to facilitate the new direction for the Department. The organizational realignment mirrors the broader philosophy of the new Administration and the Clinton-Gore Plan, an ambitious commitment to increase energy efficiency and conservation, increase natural gas use, expand the use of renewable sources of energy, and - in keeping with the theme of Program Review XI - advocate a safe, environmentally sound policy. EE and more specifically the office of Utility Technologies, has a mission to work with industry to improve the cost and performance of renewable energy technologies, including geothermal energy. Geothermal energy is a domestic energy resource with economic, reliability, and environmental advantages over other energy sources. Finally, the major piece of legislation, the Energy Policy Act of 1992 (EPAct), is discussed as relevant to renewable energy in general and geothermal in particular.

1505 Economic, Industrial, and Business Aspects

Refer also to citation(s) 6426, 6507, 6519, 6534

6509 (CONF-930484–, pp. 15-19) **Edison's QF experience.** Gould, W.R. (Southern California Edison, Rosemead, CA (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

In this paper the author summarizes the experiences of Southern California Edison with the purchase and implementation of renewable energy sources into its power generation system. Edison's interest and excitment was very high in the early 1980's when it embraced the concept of integrating such technologies into its energy base. This was short lived however, because of the contractual arrangements it was required to sign into with regard to these sources and also the number of such agreements it had to enter into. These agreements have resulted in supplying about 17 percent of Edison's capacity need and 32 percent of their energy requirements. However the cost of the contracts finds that these sources represent 65 percent of its energy budget. Fortunately for Edison the fixed contractual periods begin to expire in the late 1990's, and can be rebid at more competitive rates. Edison purchases from biomass, cogeneration, geothermal, hydroelectric, solar, and wind suppliers.

6510 (CONF-930484–, pp. 21-26) **How does it fit into the national energy agenda?.** Hinrichs, T.C. (Magma Power Company, San Diego, CA (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings:. "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This talk addresses the question of how geothermal energy fits into the broad national energy agenda. The author chooses to look at this question from the perspective of the environment, jobs, and costs. In evaluating the cost of an energy source there is a value assigned to the actual costs associated with developing the source as well as maintaining the environment. But there is also a question of value to be assigned to the social benefit associated with a non-polluting resource. The author argues the industry should emphasize its excellent environmental record, and the fact that it has little impact on local water or air pollution. The industry also has stimulated the development of new jobs in the economy. On the question of costs the author argues the industry must be cognizant of the present pressure to minimize costs in energy sources, and the fact that it is probably not as cheap as natural gas today. It must emphasize the benefits it has to offer in long term production, environmental impacts, and costs, to assure it maintains a share of the market so it can expand, develop new resources and new technology, and thereby be better able to address the countries long term energy needs.

6511 (CONF-930484–, pp. 155-163) **An estimate of the cost of electricity production from hot-dry rock.** Pierce, K.G. (Sandia National Laboratories, Albuquerque, NM (United States)); Livesay, B.J. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. DOE Contract AC04-76DP00789. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This paper gives an estimate of the cost to produce electricity from hot-dry rock (HDR). Employment of the energy in HDR for the production of electricity requires drilling multiple wells from the surface to the hot rock, connecting the wells through hydraulic fracturing, and then circulating water through the fracture system to extract heat from the rock. The basic HDR system modeled in this paper consists of an injection well, two production wells, the fracture system (or HDR reservoir), and a binary power plant. Water is pumped into the reservoir through the injection well where it is heated and then recovered through the production wells. Upon recover, the hot water is pumped through a heat exchanger transferring heat to the binary, or working, fluid in the power plant. The power plant is a net 5.1-MW binary plant employing dry cooling. Make-up water is supplied by a local well. In this paper, the cost of producing electricity with the basic system is estimated as the sum of the costs of the individual parts. The effects on cost of variations to certain assumptions, as well as the sensitivity of costs to different aspects of the basic system, are also investigated.

6512 (CONF-930484–, pp. 173-179) **Near-term demand and market analysis of geothermal electric power.** Parsons, B. (National Renewable Energy Lab., Golden, CO (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This paper covers the highlights of an analysis project addressing the electric demand and market developments that will influence the deployment of new U.S. geothermal electric plants

over the next 10-20 years. The author concludes that the opportunity for increased geothermal capacity installation is not limited by either electric market demand or overall resource potential. Instead, the installation rate of new geothermal power plants will be driven by the success of the technology in the new and evolving competitive marketplace. Historically, high guaranteed power purchase rates were a key driver of geothermal development outside the Geysers region. However, these contract terms are no longer available. Electric demand growth rates are projected to be low, but there are significant uncertainties associated with these projections that could drive up the demand for new capacity. Hydrothermal resources are available, but a large portion of the potential is in unproven areas. Once resource uncertainty is addressed, a significant market opportunity exists in western states, beyond current industry plans. Past geothermal development has taken place in states dominated by private, investor-owned utilities. The utility sector in states with resource potential but no current geothermal power plant is more diverse, with a large number of government-owned and government-financed public utilities. Important differences between private and public utilities, such as regulatory oversite, influence attitudes toward geothermal and are factors in ultimate market success. Competitive bidding has become the primary mechanism for new utility acquisitions and power contracting. Renewable electric power technologies have not fared as well under bidding as under earlier acquisition procedures based on the Public Utility Regulatory Policies Act (PURPA); however, use of integrated resource planning, and incorporation of externalities in acquisition processes, may help this problem.

1506 Environmental Aspects

Refer also to citation(s) 6516

6513 (CONF-930484–, pp. 11-14) **Geothermal energy – the environmentally responsible energy technology for the 90s: A federal perspective.** Mock, J.E. (Department of Energy, Washington, DC (United States)); Beeland, G.V. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This paper touches on the perception the public has taken over the years on the question of whether geothermal steam resources were to be viewed as an environmentally advantageous resource. In the early 1970's Senate committees labeled geothermal steam as a source for pollution free power. But later in the decade concern over the Geysers project labeled this resource as a major source of air pollution because of H_2S emissions, and forced the industry to adopt stringent emission standards, and to undergo prolonged and costly environmental impact reports. But history has shown that the industry and the regulatory agencies have been able to reach a balance so that the resource can be developed economically within environmental guidelines. And these comments can be extended to the subsequent development of hot water systems also, with a different set of concerns and regulatory hurdles. Today the public perception is that these are environmentally friendly energy sources once again.

1507 Products and By-Products

Refer also to citation(s) 6535

1508 Geothermal Power Plants

Refer also to citation(s) 6527

6514 (CONF-930484–, pp. 29-30) **Session 2: The Geysers - introductory notes.** Enedym, K.L. (Pacific Gas and Electric Company, Santa Rosa, CA (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This paper serves as an introduction to the section of the conference dealing with The Geysers project. It gives a brief review of the development of the project, and points out how the research efforts at the project have responded to recent DOE efforts to optimize research gains for dollars spent. The Geysers recently hired a consultant to review its research programs, and recommend areas for emphasis and/or change. The recommendations were: more focus on projects not just research, more impetus to provide answers to short-term needs, better communications of research results. The industry and its research teams have tried to respond to these suggestions.

6515 (CONF-930484–, pp. 117-118) **NREL Energy conversion panel review.** Stock, D. (Oxbow Power Services, Inc., Reno, NV (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This paper summarizes the recommendations of the NREL Energy Conversion Panel which met in April 1993 to discuss the DOE Geothermal program. The panel felt that DOE support is still appropriate, and should be channeled to those areas that serve to help the industry in general. Because of the diversity of the industry, in particular the differing types of thermal reservoirs being tapped, it is difficult to have a particular project impact the entire industry. The panel concluded research support was most needed in three main areas: improvements in the cost competitiveness of new steam turbine plants; improvements in the utilization of troubled or declining resources; and improvements in the utilization of low and medium temperature resources. Details are briefly highlighted for each of these areas.

6516 (CONF-930484–, pp. 119-121) **Energy conversion overview.** Lombard, D.B. (Department of Energy, Washington, DC (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This paper presents a broad overview of the DOE efforts in the area of energy conversion in the geothermal field. Cost savings have been the major impetus for such improvements in the past, but as the industry seeks to expand into broader markets, environmental factors are becoming a major concern. Much work is being directed at technology improvements which will have an impact on both of these areas. Topics discussed include: INEL efforts to validate codes used by the industry to design geothermal heat exchanger systems; experimental study of condensation in supersaturated expansion from a turbine inlet nozzle; study of thermophysical properties of ammonia-water mixtures; study of new, more environmentally benign heat rejection systems for plants; development of liners for piping and above ground steel systems, which are thermally conducting, bind well to steel, do not scale, and are corrosion-resistant; development of bonding schemes for temperature-resistant elastomers to steel, which can be used in geothermal conditions.

6517 (CONF-930484–, pp. 123-125) **Overview of the geothermal energy conversion efforts at NREL.** Anderson, J.V. (National Renewable Energy Lab., Golden, CO (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties;

Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

Within the past year, several elements of the Geothermal Energy Conversion Program has been transferred to the National Renewable Energy Program (NREL, formerly SERI). NREL is working with the DOE Geothermal Division to maintain and aggressive industry orientation for these efforts. Although NREL's participation in the program has been too brief to produce substantial results, this paper will describe some of the relevant NREL experience in heat cycles and power generation systems, outline the current structure of the program for fiscal year 1993 (FY 1993), and briefly describe some of the efforts under consideration for FY 1994.

6518 (CONF-930484–, pp. 127-131) **Investigations of the condensation behavior of supersaturated turbine expansions.** Mines, G.L. (Idaho National Engineering Lab., Idaho Falls, ID (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. DOE Contract AC07-76ID01570. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

In the Heat Cycle Research project, investigators are developing a technology base permitting an increased utilization of the moderate-temperature, liquid-dominated geothermal resource for the production of electrical power. Project investigations have focused upon improvements to the binary cycle which has the potential for a higher utilization of the resource, in terms of power produced per unit mass of brine, than the flash-steam cycle. Investigations to date, have confirmed the technology required to incorporate a number of the concepts which will result in the binary cycles having a performance approaching practical thermodynamic maximums. The final concept to be investigated for this optimized cycle, is the utilization of supersaturated turbine expansions. In these processes, the working fluid is expanded through the two-phase region, exiting the turbine at slightly superheated conditions. If during this expansion process, the working fluid was at equilibrium conditions, liquid condensate would form. If it can be shown that this expansion is a metastable process, where the condensate does not form, then additional cycle performance improvements can be realized. Relative to the performance of the advanced cycle, an additional 8% improvement in the brine utilization can be realized if it can be shown that these expansions can proceed without droplet formation and without significant performance degradation. Studies also indicate that performance cycles using single component working fluids and operating above the critical pressure can also realize performance improvements, though perhaps not to the same degree. Investigations in the project are defining those conditions which result in the formation of condensate, and whether the theoretical projections relative to when condensate would form, remain valid.

6519 (CONF-930484–, pp. 145-147) **Hot dry rock: What does it take to make it happen.** Duchane, D.V. (Los Alamos National Lab., Los Alamos, NM (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

The ubiquitous heat in hot dry rock (HDR) is an abundant, widely distributed form of geothermal energy. Until recently, development of this energy source has been largely focused on understanding the scientific and engineering principles involved in forming and operating HDR reservoirs. During the past year, however, a pilot facility at Fenton Hill, NM has been run under steady-state conditions simulating the operation of a commercial HDR energy plant. Issues important to commercialization such as sustainability of thermal production, water loss, operating costs, and others have been addressed to the extent possible. The results, while not always definitive, have been encouraging. The stage is now set for the formation of an initiative led by private industry to take HDR technology from its current state of scientific and engineering demonstration to the production and marketing of energy in commercial quantities. Because of the technology risks involved, this can probably only be accomplished through a cost-shared industry/government effort. The potential rewards are great, since HDR represents the best, and perhaps the only, opportunity for geothermal energy to take its rightful place as a major energy source for the 21st century.

6520 (CONF-930484–, pp. 149-154) **Recent flow testing of the HDR reservoir at Fenton Hill, NM.** Brown, D.W. (Los Alamos National Lab., NM (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

The principal objective of the recent flow testing of the Phase II Hot Dry Rock (HDR) reservoir at Fenton Hill, NM has been to demonstrate its long-term viability as a significant source of thermal energy. However, with an aggregate of only about 8 months of production to date, this objective has obviously not yet been accomplished. Starting in April 1992, two periods of steady-state reservoir flow testing were conducted, which are here referred to as the first (16-week long) and second (8-week long) phases of the Long-Term Flow Test (LTFT). These two segments of the LTFT – April through July 1992 and February through April 1993 – were conducted at an aseismic (nonextensional) injection pressure of about 3960 psi (27.3 MPa) and at a production well between these two phases of the LTFT included a lower-injection-pressure flow test lasting about 6 weeks and a 2-month period of flow testing at the LTFT injection pressure of 3960 psi, but at even higher levels of production well back-pressure – 1800 and 2200 psi (12.4 and 15.2 MPa). The permeation loss from the boundaries of the reservoir decreased from an average of about 12.5 gpm (0.79 l/s) during the first phase of the LTFT to 7.3 gpm (0.46 l/s) near the end of the second phase of the LTFT. This low but apparently still declining water loss is remarkable considering the very large volume of fractured rock (about 16×10^6 m^3) comprising the flow-connected Phase II reservoir region. The long-term testing of the Phase II reservoir at Fenton Hill under stable, aseismic conditions has shown no thermal drawdown during almost 8 months of flow testing. This conclusion is based primarily on downhole measurements of the fluid temperature level just above the 1130-ft (344-m) multiple-entrance production zone in the production well, which indicate that there has been no change in the mixed-mean reservoir outlet temperature between July 1992 and March 1993.

1509 Geothermal Engineering

Refer also to citation(s) 6496, 6503, 6514, 6515, 6516, 6517, 6519, 6520, 6533

6521 (CONF-930484–, pp. 37-45) **Geysers reservoir studies.** Bodvarsson, G.S. (Lawrence Berkeley Lab., CA (United States)); Lippmann, M.J.; Pruess, K. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. DOE Contract AC03-76SF00098. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties"*. 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

Lawrence Berkeley Laboratory is conducting several research projects related to issues of interest to The Geysers operators, including those that deal with understanding the nature of vapor-dominated systems, measuring or inferring reservoir processes and parameters, and studying the effects of liquid injection. All of these topics are directly or indirectly relevant to the development of

reservoir strategies aimed at stabilizing or increasing production rates of non-corrosive steam, low in non-condensable gases. Three reservoir engineering studies are described in some detail, that is: (a) Modeling studies of heat transfer and phase distribution in two-phase geothermal reservoirs; (b) Numerical modeling studies of Geysers injection experiments; and (c) Development of a dual-porosity model to calculate mass flow between rock matrix blocks and neighboring fractures.

6522 (CONF-930484–, pp. 47-53) **Southeast Geysers injection and reservoir model study.** Faulder, D.D. (Idaho National Engineering Lab., Idaho Falls, ID (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. DOE Contract AC07-76ID01570. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

Water injection at the Geysers began in 1969 as a means of cooling-tower waste-water disposal. Simple disposal of water has gradually evolved into an accepted means of maintaining reservoir production. However, operator success with injection has varied widely. If injection is to be expanded at The Geysers, it is important to understand the processes of injection, vaporization and production of injectate and then to use this understanding to predict the behavior of the field during injection. Insight into these processes can be gained by studying historical injection at The Geysers and then using reservoir simulators to predict reservoir performance under various injection plans. A calibrated model of a portion of the Unit 13 area in the southeastern region of The Geysers steam field was used to evaluate historical injection efficiency of two injection wells and to then optimize reservoir performance through studying several injection scenarios. This study used historical production data to model reservoir performance using the TETRAD simulator. Naturally occurring isotopic data was utilized as a tracer of injected fluid and a measure of injection derived steam (IDS) in a manner as discussed by Beall et al.. This area of The Geysers was selected for study because injection spans thirteen years and includes two injection wells, exploitation started at essentially undisturbed conditions and reservoir performance is well documented in the literature.

6523 (CONF-930484–, pp. 75-76) **LBL industry review.** Benoit, D. (Oxbow Power Services, Inc., Reno, NV (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This is a general summary of a meeting on March 16, 1993 of the LBL Industry Review Panel on Exploration and Reservoir Technology. It met in three subpanels to consider (1) exploration for new discoveries (2) mapping reservoir properties and monitoring production/injection (3) well testing, reservoir simulation, and predicting future reservoir performance. This very brief meeting only allowed very broad coverage of concerns. There is a growing commercial development of liquid based geothermal reservoirs, and they are encountering problems for which they are asking for research dollars. This will probably cause a shift in research spending as there is a limited number of dollars available, and the vapor based Geysers has received most funding to this point. All three panels felt the need to see more case studies, whether they reached positive or negative conclusions. This may be forthcoming as consolidation in the industry is reducing the need to shield information from competitors.

6524 (CONF-930484–, pp. 99) **Introduction to drilling research.** Hamblin, J. (Unocal Geothermal Division, Santa Rosa, CA (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This paper is a brief introduction to research projects in the area of drilling technology. A technical panel, composed of representatives of geothermal operators, drilling contractors, and service companies, met in Albuquerque, and heard presentations on various drilling related projects which are ongoing or planned. These projects are fairly small scale, partially funded by DOE, administered through Sandia National Laboratory, and generally cooperative in nature between industry and the laboratory. The author briefly discusses the seven highest rated projects, both by the researchers and the conferees. They are: hard rock bits, slimhole drilling, memory logging tools, lost circulation, the Geothermal Drilling Organization, the Long Valley Exploratory Well, and acoustic telemetry.

6525 (CONF-930484–, pp. 101-103) **Overview-hard rock penetration.** Dunn, J.C. (Sandia National Laboratories, Albuquerque, NM (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

The Hard Rock Penetration program is developing technology to reduce the costs of drilling and completing geothermal wells. Current projects include: lost circulation control, borehole instrumentation, acoustic telemetry, slimhole drilling, geothermal heat pumps. A new project to improve synthetic diamond drill bits for hard rock drilling was initiated during the year. Accomplishments during the year include completion of important acoustic telemetry tests in the Long Valley Well. These tests produced the first set of reliable, repeatable data in a drill hole. The results indicate the promise of acoustic transmission through drill pipe for great distances without repeaters. The rolling float meter for measuring drilling fluid outflow was duplicated and sent to six different companies for evaluation in the field. A new slimhole spectral gamma tool for operation at temperatures up to 300 C was fabricated and evaluated in the laboratory. Slimhole drilling for exploration and reservoir characterization was begun with several projects jointly completed with industry.

6526 (CONF-930484–, pp. 105-109) **Status of lost circulation research.** Glowka, D.A. (Sandia National Laboratories, Albuquerque, NM (United States)); Schafer, D.M.; Wright, E.K.; Whitlow, G.L.; Bates, C.W. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. DOE Contract AC04-76DP00789. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This paper describes progress made in the Lost Circulation Technology Development Program over the period March, 1992-April, 1993. The program is sponsored at Sandia National Laboratories by the U.S. Department of Energy, Geothermal Division. The goal of the program is to develop technology to reduce lost circulation costs associated with geothermal drilling by 30-50%.

6527 (CONF-930484–, pp. 133-140) **Geothermal materials development activities.** Kukacka, L.E. (Brookhaven National Lab., Upton, NY (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally*

Responsible Energy Technology for the Nineties". 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

This ongoing R&D program is a part of the Core Research Category of the Department of Energy/Geothermal Division initiative to accelerate the utilization of geothermal resources. High risk materials problems that if successfully solved will result in significant reductions in well drilling, fluid transport and energy conversion costs, are emphasized. The project has already developed several advanced materials systems that are being used by the geothermal industry and by Northeastern Electric, Gas and Steam Utilities. Specific topics currently being addressed include lightweight CO_2-resistant well cements, thermally conductive scale and corrosion resistant linear systems, chemical systems for lost circulation control, elastomermetal bonding systems, and corrosion mitigation at the Geysers. Efforts to enhance the transfer of the technologies developed in these activities to other sectors of the economy are also underway.

6528 (CONF-930484–, pp. 143-144) **Geothermal Energy - the environmentally responsible energy technology for the nineties.** Capuano, L.E. (ThermaSource Inc., Santa Rosa, CA (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

The primary topic which is discussed in this section of the workshop on advanced technologies is the hot-dry-rock project. Approximately 175 million dollars was spent on this project over 20 years. It was just shut down due to lack of funding, just prior to completion of long term pumping tests. The facility at Fenton Hill was in the process of doing long term pumping tests, and on its third set of pumps was finally achieving fairly reliable operation. This paper summarizes some of the work being done on this project, prior to its termination. Committees have been formed to locate potential sites in California and on the east coast for new hot-dry-rock installations.

6529 (LA-UR–93-3695) **Geothermal energy production from hot dry rock: Operational testing at the Fenton Hill, New Mexico HDR Test Facility.** Duchane, D.V. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940326–1: American Society of Mechanical Engineers (ASME) international solar energy conference, San Francisco, CA (United States), 27-30 Mar 1994). Order Number DE94002717. Source: OSTI; NTIS; GPO Dep.

During 1992–1993, an extended operational testing program was conducted at the Fenton Hill, NM Hot Dry Rock (HDR) test facility. Approximately 6.3 l/s (100 gpm) of water was circulated for a total period of about 8 months through an artificial geothermal reservoir located about 3.5 km (11,500 ft) below the surface. Hot water was continuously returned to the surface at temperatures of 180–190°C (355–375°F). Under steady-state operating conditions, the temperature of the fluid produced from the reservoir showed no measurable decline over the span of the testing. In fact, tracer evidence indicated that access to hot rock increased as flow was directed preferentially to longer and longer pathways through the reservoir as the testing proceeded. The amount of water lost in passing through the underground reservoir also declined with time, eventually reaching levels of only about 7% of the injected volume. Operating performance data verified that significantly more energy was produced than was required to run the test facility. Geochemical measurements indicated persistently low levels of dissolved solids and gases in the circulating fluid. Because the entire system was pressurized, nothing except waste heat was released to the atmosphere during the closed-loop testing. The test program provided new information with regard to thermal, hydraulic, operational and environmental issues concerned with the development of HDR geothermal energy plants. The data gathered in this test will form the basis for the development of facilities to produce and market energy from HDR on a commercial scale. This paper reviews the results of the recent HDR flow testing program in detail and discusses the next steps required to move HDR technology toward full commercial application as an economic process for producing clean energy.

6530 (NEDO-P–9211) **Research on acidic brine prevention technology.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 293p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE94732337. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The paper investigates acidic brine which a factor inhibiting the geothermal development, from the viewpoints of prediction, measures and effective use. The investigation predicts that the deeper the area to be developed is, the greater the possibility of spouting of acidic brine is. Its amount as resource is 13-30% of the total resource amount in Japan. As prediction technology for acidic brine, there are geological, geochemical and geophysical methods before excavation. Cores and cuttings obtained during well drilling are helpful information sources. In addition, there is a technology analyzing the origin and behavior of acidic brine. Utilization of isotopes including ^{34}S is effective for the study of the origin. It is also necessary to compile geothermal models. In relation between alteration mineral and acidic activity, the analysis using fluid inclusion is paid attention to. To study measures for and effective utilization of acidic brine, examination should be made mainly on results form oil and gas wells and applicability of those to geothermal wells, anti-scale techniques and economical efficiency when using high-quality materials. 164 refs., 100 figs., 52 tabs.

1520 Geothermal Data and Theory

Refer also to citation(s) 6498, 6503, 6522, 6530, 6534

6531 (CONF-930484–, pp. 65-71) **Experimental study of water adsorption on Geysers reservoir rocks.** Shang, S. (Department of Petroleum Engineering, Stanford, CA (United States)); Horne, R.N.; Ramey, H.J. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

Experimental isotherms of water vapor adsorption/desorption on three geothermal reservoir rock samples have been measured at temperatures of 80, 100, 120 and 140°C. Initial surface status of the sample was found to influence the amount of water adsorbed. At low relative pressures, adsorption is the dominant process of water retention onto the rock samples. Adsorption/desorption hysteresis was observed to exist over the whole pressure range at all temperatures. Similar observations were made for all three samples. The results of this study suggest that adsorption is important in storing water in geothermal reservoir rocks not only in itself, but also in inducing capillary condensation.

6532 (CONF-930484–, pp. 85-90) **Gas geochemistry of The Geysers geothermal field.** Truesdell, A.H. (Lawrence Berkeley Lab., Menlo Park, CA (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

Increases in gas concentrations in Central and Southeast Geysers steam are related to the decreases in pressure caused by heavy exploitation in the 1980s. When reservoir pressures in the central parts of the field decreased, high-gas steam from undrilled reservoir margins (and possibly from underlying high-temperature zones) flowed into exploited central areas. The Northwest Geysers

reservoir probably lacks high-gas marginal steam and a decline in pressure may not cause a significant increase of gas concentrations in produced steam.

6533 (CONF-930484–, pp. 181-184) **Brine (solution, solid, gas phases) modeling program: Advanced technology to aid in the economical development of geothermal resources.** Noller, N. (Univ. of California, San Diego, CA (United States)); Weare, J.H.; Duan, Z.; Greenberg, J.P. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

The objective of this program is to improve the productivity of geothermal resources by providing modeling tools for predicting and mitigating chemical problems associated with the extraction of energy from geothermal brines. These easily accessible models will provide reliable predictions of the behavior of the resource (e.g., scaling and breakout) under arbitrary conditions, thereby providing operators, engineers and designers with the ability to rapidly analyze potential problems and to test strategies for problem abatement and resource enhancement. The project objective also includes effective communication with the geothermal industry in order to exchange ideas and transfer technology.

1540 Waste Management

6534 (CONF-930484–, pp. 167) **Potpourri session overview.** Hooper, G.J. (Department of Energy, Washington, DC (United States)). USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

Unlike most of the earlier sessions, which focused on a specific topic or research area, this session covered a diverse group of projects. The presentations ranged from an overview of the low-temperature resource assessment program (including geothermal heat pumps) to a review of bioprocessing techniques being used to remove undesirable elements from geothermal residual wastes. The author briefly highlights the different presentations: low temperature assessments; near-term demand and market-side analysis of geothermal electric power; biochemical treatment of getothermal wastes; geothermal brine chemistry model; Bonneville Power Administration geothermal activities.

6535 (CONF-930484–, pp. 185-190) **Geothermal waste treatment biotechnology.** Premuzic, E.T. (Brookhaven National Lab., Upton, NY (United States)); Lin, M.S.; Jin, J.Z. USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (United States). Geothermal Div. [1993]. Contract AM-35-10. From 11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993. In *Proceedings: "Geothermal Energy: The Environmentally Responsible Energy Technology for the Nineties".* 221p. Order Number DE94001714. Source: OSTI; NTIS; GPO Dep.

An ongoing R&D program at the Brookhaven National Laboratory (BNL) has identified technologies for a low cost, environmentally acceptable disposal of toxic geothermal residues. Laboratory work has shown that a biochemical process would meet the cost requirements. In this work, microorganisms which can interact with toxic metals (including trace radionuclides) found in geothermal residual brine sludges and which can convert them into soluble species for subsequent reinjection or concentration have been identified. The biochemical activities of these organisms served as models for the development of technically and economically feasible detoxification processes leading to advanced biotechnology for geothermal waste treatment. Process variables have been identified and optimization studies have been carried out using a prototype laboratory scale pilot-plant for detoxification processing. A concurrent process for the concentration and recovery of valuable metals is also being developed. In this process a better than 80% removal of toxic metals is achieved in short periods of time. The fast rates of metal removal, with residence time in the bioreactor of 4 to 25 hours, have been achieved at pH 1-2 and temperatures of 55-60°C. A secondary biochemical process for the removal of trace radionuclides, particularly radium is currently being developed and tested. A complimentary process for concentration of metal from the process byproducts, i.e., the aqueous phase, produces a water effluent which meets drinking water standards.

16 TIDAL AND WAVE POWER

Refer also to citation(s) 6329

1601 Resources and Availability

Refer also to citation(s) 7473

1605 Environmental Aspects

6536 (ETSU-T–04/00195/REP) **Tidal regimes and salt marshes - the River Hamble analogue.** Gray, A.J. (Institute of Terrestrial Ecology, Furzebrook (United Kingdom)); Moy, I.L.; Warman, E.A.; Dawson, F.H.; Henville, P. Institute of Terrestrial Ecology, Furzebrook (United Kingdom); Institute of Freshwater Ecology, Wareham (United Kingdom). 1993. 57p. Sponsored by AEA Environment and Energy, Harwell (United Kingdom). Order Number DE94726336. Source: OSTI; NTIS (US Sales Only); INIS.

Construction of estuarine tidal-energy barrages has a potentially major effect on the tidal regime of the estuary, particularly upstream of a barrage. Because tidal regime largely controls the distribution and species composition of intertidal plant and animal communities, it is important to understand how barrages may affect such communities. The main objectives of the research described in this report were to relate recent changes in tidal regime within an embanked area of salt marsh and mudflat to changes in the distribution of plant species. This was to test predictions about tidal control of species' range and to assess the site's suitability as an analogue of post-barrage conditions. (author)

1608 Wave Energy Converters

6537 (ETSU-WV–1692) **Bristol cylinder wave energy device; consultancy to review of wave energy.** Shawater Ltd., Bath (United Kingdom). 1992. 115p. Sponsored by AEA Environment and Energy, Harwell (United Kingdom). Order Number DE94730470. Source: OSTI; NTIS (US Sales Only).

Prepared in association with Mannesmann Rexroth Ltd., St. Neots (GB), Strachan and Henshaw Ltd., Bristol (GB) and Powersystems (UK) Ltd., Bristol (GB).

A review of possible power conversion systems for the Bristol Cylinder wave energy device is reported and justification for the preferred option is given. It is shown that, for demonstration and early production units, off-the-shelf equipment could be used for the principal components of this option and it is expected that all other items could also be standard. With the device proven on this basis, the report sets out the areas in which improvements to costs and performances can be expected as a result of well targeted development work. (author)

17 WIND ENERGY

Refer also to citation(s) 6329

1701 Resources and Availability (Climatology)

Refer also to citation(s) 7404

6538 (PNL-SA–22124) **New parameters for characterizing turbulence at a potential wind site.** Wendell, L.L.; Barnard, J.C.; Morris, V.R. Pacific Northwest Lab., Richland, WA (United States). Jul 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930726–7: Windpower '93, San Francisco, CA (United States), 12-16 Jul 1993). Order Number DE94004355. Source: OSTI; NTIS; GPO Dep.

The most widely used parameter for characterizing turbulence at a potential wind turbine site has been the quantity called "Turbulence Intensity" (TI). Analyses of data from several sites in the US Department of Energy's Turbulence Characterization Project show that this parameter can sometimes be seriously misleading. This project has produced a data base of three-component wind turbulence at four strategic locations over a rotor disk in different types of complex terrain. The 0.2-s sampling interval of the data from the four anemometers makes it possible to compute a composite wind over the rotor disk, as well as the wind experienced at a point on a rotating wind turbine blade. From considerations of specialized plots of these wind data, the authors have introduced engulfing gust (TEG) and fluctuating shear (TFS) turbulence parameters and compared their behavior with TI over a range of wind speeds at sites with different terrain configurations. The comparisons showed TEG and TFS to be somewhat more discriminating than TI of the nature of the turbulence at different sites. To obtain a more complete understanding of the nature of the turbulence and its relationship to upwind terrain features, shaded relief and cross-section analyses were applied to provide an overview of the upwind fetch. Using these analyses, along with the time-series plots of wind speed, allowed us to detect eddies being shed from an upwind feature at one site, and to detect a subtle difference in ridge configuration between two sites that resulted in flow separation at one site, but not at the other.

1703 Legislation and Regulations

6539 (ETSU-W–35/00290/REP) **Institutional consents and detailed site investigation for a demonstration offshore wind turbine: Phase 1 report.** Renewable Energy Systems Ltd., Hemel Hempstead (United Kingdom). 1993. 169p. Sponsored by AEA Environment and Energy, Harwell (United Kingdom). Contract E/5A/6108/2962. Order Number DE94726334. Source: OSTI; NTIS (US Sales Only); INIS.

The objectives of the projects was to address all outstanding technical, statutory and commercial issues prior to detailed design, construction and installation of a demonstration offshore turbine. Phase 1, which is the subject of this report, addressed the statutory and other agreements necessary, legal issues, and preparations for detailed site investigations and studies of the wave climate and potential for scour at the proposed site. (author)

1704 Economic, Industrial, and Business Aspects

Refer also to citation(s) 6426

6540 (NEI-SE–137) **On wind power in the Nordic countries.** Nilsson, Lars J. Lund Inst. of Tech. (Sweden). Dept. of Environmental and Energy Systems Studies. 1993. 24p. Order Number DE94730421. Source: OSTI; NTIS; INIS.

Paper included in the dissertation of Lars J. Nilsson.

The purpose of this article is to discuss the prospects for a large scale introduction of wind power in the Nordic countries especially with respect to the consequences for small independent power producers of the ongoing and planned deregulation of the electricity sector. The recoverable wind resources are great and integration costs are small due to the good load following capability of the existing Swedish and Norwegian hydroelectric capacity. The structure of the present electricity system and the current principles for electricity trade are reviewed. To what extent wind power will be the technology of choice for capacity replacement and expansion depends on how intermittent power will be valued on the future electricity market. In a deregulated market, wind power may be priced below its value unless appropriate pricing mechanisms are developed. Market reforms should therefore include consideration of the large contribution that wind energy must make in a future electricity system which, in addition to being economically efficient, is compatible with broader societal goals. 47 refs, 2 figs

1705 Environmental Aspects

Refer also to citation(s) 6539

6541 (ETSU-WN–6056/030) **Effects of wind turbines on UHF television reception: field tests in Denmark.** Sorenson, B. Perma Energy Ltd., Milton Keynes (United Kingdom). 1992. 33p. Sponsored by AEA Environment and Energy, Harwell (United Kingdom). Order Number DE94730467. Source: OSTI; NTIS (US Sales Only); INIS.

As a result of a planning application for a windfarm comprising 20 wind turbines at Tynewydd Farm, Gilfach Goch in Mid Glamorgan, a report discussing any detrimental effects the proposal might have on u.h.f. television reception was produced. In order to make the report as definitive as possible, it was decided to carry out field tests on the exact model of wind turbine to be used at Tynewydd. This required a field trip to Denmark, and the opportunity was taken to make measurements on two other models of turbine at the same time. This report presents the analysis of the results for all three turbines. (author)

1706 Wind Energy Engineering

Refer also to citation(s) 6539

6542 (DOE/FTR–94002465) **Travel to Europe to collaborate on wind turbine aerodynamics and testing: Foreign trip report, September 15–23, 1993.** Simms, D.A. National Renewable Energy Lab., Golden, CO (United States). 15 Oct 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94002465. Source: OSTI; NTIS (US Sales Only); GPO Dep.

On September 16 and 17, 1993, the first official meeting of IEA Annex XIV "Field Rotor Aerodynamics" was held at RISO National Laboratory in Roskilde, Denmark. Topics discussed at this meeting of the newly-formed Annex centered around planning and coordinating research objectives and activities between all of the participants. There are 5 participating organizations from 4 countries, and each will be conducting detailed aerodynamic test programs to investigate steady and unsteady aerodynamic behavior on full-scaled wind turbines. The participants gave presentations describing their test plans and the status of their facilities. Detailed discussions were then held to finalize the formats of the measurement programs and information exchange. Initial sample data sets were prepared and exchanged by those participants who already had data. On September 20, a meeting and site visit was conducted at the ECN facility near Petten, Netherlands. ECN is in the process of checking out their aerodynamic pressure force measurement system on a non-rotating outdoor test facility. The 12.5 m blade has been instrumented and installed on a test stand which holds the blade horizontally for work access, and tilts it vertically if sufficient winds are available to generate aerodynamics forces to test the measurement system. ECN's test plan has been delayed due to rain and low winds all summer. Once these tests are completed and they are sure the system is operating as required, they plan to install the blade on their 25 m custom test-bed turbine. On September 22, a meeting and site visit was held at the Rutherford Appleton Laboratory/Royal Imperial College Test Facility in the UK. They have completed wind tunnel testing and are in the process of building a ruggedized pressure measurement system and refurbishing the Wind Harvester test turbine on which the instrumented 8.5 m LM airfoil is to be installed.

6543 (ECN-C–93-072) **Test FLEXTEETER: Volume 1: Main body of the report.** Dekker, J.W.M. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Dec 1993. 41p. Contract NOVEM 24.710/9010; Contract CEC-DG12 EN3W-0064-NL; Proj Order Number DE94729864. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

A two-bladed rotor (FLEXTEETER) equipped with an elastomeric teeter, flexible beams and passive control tips was tested at the

25m Horizontal Axis Wind Turbine (HAWT) rotor test facility at the Netherlands Energy Research Foundation (ECN) in Petten. This project formed the second and final field test within the framework of the FLEXHAT program, in which technology for the next generation of wind turbines is developed. The objectives of the title test were to demonstrate stable and safe operation of the flexible rotor and to confirm the predicted load reduction by measurements. In this volume results of field tests with the FLEXTEETER as well as the stiff rotor 20-WPX-PRT1 are surveyed and if applicable compared with results of the test of 20-WPX-THR rotor blades. The main part of this report concerns a description of the measurement program. In the second and third volume test reports concerning several parts of the FLEXTEETER test project are given in the form of appendices A-F and G-L. 17 figs., 5 tabs., 17 refs.

6544 (ECN-C–93-078) **Mechanical loads prediction for the WPS-30 wind turbine in the Sexbierum wind farm: Volume 1.** Bulder, B.H.; Schepers, J.G. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Nov 1993. 76p. Contract SEP 871021/Po-1718. Order Number DE94729859. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

The figures and tables of the report are published separately in volume 2, as report ECN-C–93-079.

The aim of the title project was to investigate the maturity of rotor load calculation models and codes by means of which increased loads caused by wind farm operation can be determined. Part of the project concerns the normal production load conditions, calculated by using the so-called Dutch wind handbook. Another part concerns a number of special load conditions, selected at forehand and measured during campaign measurements (event recordings). The results of the simulation of these special load cases, in time and frequency domain, are compared with measurements, which include also rainflow (Markov) matrices of the continuously measured loads. The comparison is performed on the basis of power spectral densities, the azimuthal binned averages, the rainflow cycles and the 1 Hz (fatigue) equivalent value of the different load signals. The calculations were performed by means of PHATAS-2 (rotor code in time domain), TURBU-1 (ibid, but now in frequency domain) and SWIFT (stochastic wind field simulator) computer codes. A conceivable result is that increase in loading for a wind turbine in a wind farm depends on the spacing of the turbine in the farm. 3 appendices, 30 refs.

6545 (ECN-C–93-079) **Mechanical loads prediction for the WPS-30 wind turbine in the Sexbierum wind farm: Volume 2: Tables and figures.** Bulder, B.H.; Schepers, J.G. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Nov 1993. 84p. Contract SEP 871021/Po-1718. Order Number DE94729858. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

The text of this report is published in volume 1 (report number ECN-C–93-078).

The aim of the title project was to investigate the maturity of rotor load calculation models and codes by means of which increased loads caused by wind farm operation can be determined. Part of the project concerns the normal production load conditions, calculated by using the so-called Dutch wind handbook. Another part concerns a number of special load conditions, selected at forehand and measured during campaign measurements (event recordings). The results of the simulation of these special load cases, in time and frequency domain, are compared with measurements, which include also rainflow (Markov) matrices of the continuously measured loads. The comparison is performed on the basis of power spectral densities, the azimuthal binned averages, the rainflow cycles and the 1 Hz (fatigue) equivalent value of the different load signals. The calculations were performed by means of PHATAS-2 (rotor code in time domain), TURBU-1 (ibid, but now in frequency domain) and SWIFT (stochastic wind field simulator) computer codes. A conceivable result is that increase in loading for a wind turbine in a wind farm depends on the spacing of the turbine in the farm. 3 appendices, 30 refs.

6546 (ECN-I–93-036) **Determination of 2D equivalent angles of attack for a non-rotating wind turbine rotor blade.** Maassen, W.H. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Nov 1993. 128p. Project ECN 4240.01. Order Number DE94729861. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

This student's report is part of the aerodynamic research programme of the Wind Energy Group at the business unit Renewable Energy of the Netherlands Energy Research Foundation ECN, Petten, Netherlands.

For the investigation into models to compute the title subject use has been made of the Lanchester-Prandtl lifting line model. The inflow conditions are given by a uniform inflow velocity and the geometrical angles of attack at every spanwise position. A model using pressure measurements at the instrumented sections and a model using 2-dimensional C_L-α data at certain spanwise positions were investigated. In section two the experimental setups of the experiments at ECN (Netherlands Energy Research Foundation) and FFA (the Aeronautical Research Institute of Sweden) are presented. In section three the theoretical background and the different methods to compute the 2D equivalent angles of attack are outlined. In section four the results of the computations of the downwash and the 2D equivalent angles of attack for the considered FFA wind tunnel experiment is presented. Finally, in section five the most important conclusions are summarized and a recommendation for the computation of the 2D equivalent angles of attack for the non-rotating blade experiments at ECN is formulated. 59 figs., 2 tabs., 3 appendices, 30 refs.

6547 (ECN-R–93-005) **On the measurement of inflow velocity and inflow angles with a spheric probe.** Brand, A.J. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Jun 1993. 58p. Project ECN 4240.01. Order Number DE94729810. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

This work is part of the 'field rotor-aerodynamics' project funded by the Netherlands Ministry of Economic Affairs. The main body of the work was performed in the second quarter of 1992, and the first quarter of 1993.

For a spheric probe with five measuring points on its surface, the magnitude and the direction of the inflow velocity is a function of three pressure coefficients. These inflow quantities can therefore be determined by measuring the pressure coefficients. Wind tunnel tests of such a probe revealed that there is a linear relation between the measured and the theoretical value of the inflow quantities, provided that the geometric base angle is not too large and the effective base angle is determined experimentally. The base angle defines the position of the measuring points. If the resolution of the pressure measurements is not sufficient, these relations must be used as calibration lines. 21 figs., 2 tabs., 4 appendices, 8 refs.

6548 (ETSU-N–125) **Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.** McAnulty, K.F. (ed.). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. 215p. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

IEA R and D WECS experts meeting.

One of the activities covered in this conference is the joint action on the aerodynamics of wind turbines. The papers in this volume were presented at a two day symposium held on the 30th November and 1st December 1992 at the Netherlands Energy Research Foundation, Petten as part of a series of similar meetings held approximately annually at different locations. Sixteen presentations were made covering the following topics: load calculations; aerofoil characteristics; dynamic stall; stall induced vibrations; and fluid dynamic computations. The meeting structure was informal, consisting of presentations of the topics followed by discussion. Twenty-one researchers from five countries attended, providing stimulating discussion on a range of important topics in wind turbine aerodynamics. (author)

6549 (ETSU-N–125, [pp. 8]) **Simulation of loads on a pitch controlled wind turbine during an emergency stop.** Oeye, S. (Danmarks Tekniske Hoejskole, Lyngby (Denmark). Afd. for Fluid Mekanik). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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The usual way of stopping a pitch controlled wind turbine in a case of emergency is by pitching the blades towards the feathered position at a high rate. This produces a negative aerodynamic torque which stops the turbine. At the same time a large negative flapwise load is developed on the blades. Therefore, the emergency stop can be an important design case. Unfortunately, experience shows that the loads in this case are difficult to predict, often resulting in serious underestimation of the loads, probably because of the highly transient nature of the case. In this paper a comparison is made between measured and calculated flapwise blade root bending moments for the Tjaereborg Wind Turbine using different aerodynamic models for calculation of the blade loads. (author)

6550 (ETSU-N–125, [pp. 8]) **Induced velocities for rotors in yaw: An extension of the blade element momentum method.** Oeye, S. (Danmarks Tekniske Hoejskole, Lyngby (Denmark). Afd. for Fluid Mekanik). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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A modification to the Blade Element Momentum method is proposed in order to include the effects of yaw in the calculation of the induced velocities for a wind turbine rotor. (author)

6551 (ETSU-N–125, [pp. 15]) **The design and testing of airfoil DU 91-W2-250: Including the effect of vortex generators and gurney flaps.** Timmer, W.A. (Delft Univ. of Technology (Netherlands). Inst. for Wind Energy). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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Airfoils of the NACA six digit series of airfoils are still widely used for application in horizontal axis wind turbines. Due to the combination of camberline and thickness distribution specific for these series the airfoils exhibit a decrease in performance with increasing relative thickness, especially with respect to roughness. As a first step to find alternatives for thick airfoils of the NACA 63 and 64 series a 25% thick airfoil was designed. The airfoil was designated DU 91-W2-250 and wind tunnel tested in the low speed wind tunnel of Delft University of Technology. (author)

6552 (ETSU-N–125, [pp. 11]) **Modification of airfoil characteristics by the three dimensional potential flow of horizontal axis windturbine rotors.** Bussel, G.J.W. van (Delft Univ. of Technology (United Kingdom). Inst. for Wind Energy). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

IEA R and D WECS experts meeting.

The use of inviscid incompressible aerodynamics, and asymptotic acceleration potential theory are used to provide an improved description of flow near the blades of horizontal axis windturbine rotors. Various computer codes are used to model three-dimensional potential flow around the turbine blades. Experimental results reveal good possibilities for the asymptotic acceleration potential method. (UK)

6553 (ETSU-N–125, [pp. 12]) **Experimental results on noise and airfoil performance of wind turbine rotor blades.** Cornelius, V. (Deutsches Windenergie-Institut, Wilhemshaven (Germany)); Kramkowski, T. AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

IEA R and D WECS experts meeting.

Poster format is used to present experimental data on noise and airfoil performance of wind turbine rotor blades. Aerodynamic aspects of aerowatt rotor blade noise, airfoil and rotor blade tip noise are explored using wind tunnel experiments. A comparison of the performance of an intended and constructed airfoil is also included. (UK)

6554 (ETSU-N–125, [pp. 18]) **Wind tunnel measurements on a stalled horizontal axis wind turbine rotor.** Graham, J.M.R. (Imperial Coll. of Science, Technology and Medicine, London (United Kingdom). Dept. of Aeronautics). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

IEA R and D WECS experts meeting.

This contribution describes measurements of the stalling behaviour of a model of a prototype stall controlled horizontal axis wind turbine rotor. The rotor model was based on the geometry of the WEG stall controlled rotor. Mean and fluctuating blade surface pressure measurements and flow visualisation tests using smoke and temperature sensitive liquid crystal paint were performed. (author)

6555 (ETSU-N–125, [pp. 10]) **A hybrid wake model for HAWT.** Bareiss, R. (Stuttgart Univ. (Germany). Inst. fuer Aerodynamik und Gasdynamik); Wagner, S. AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

IEA R and D WECS experts meeting.

A hybrid works model is developed for a horizontal axis wind turbine. The study aims to produce load calculations for the rotor, as well as supporting the validation and development of engineering models. Noise prediction tools are developed on an aerodynamic basics. Good agreement is found between calculation and measurement for the hybrid wake model. (UK)

6556 (ETSU-N–125, [pp. 19]) **Sectional prediction of 3D effects for separated flow on rotating blades.** Snel, H. (Netherlands Energy Research Foundation (ECN), Petten (Netherlands)); Houwink, R.; Piers, W.J. AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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A method is presented which allows the computation of airload coefficients for rotor blade sections in attached and separated flow conditions, including the leading effects of blade rotation. The method consists of an existing computer code for two-dimensional unsteady flow with strong viscous-inviscid interaction, in which the turbulent boundary layer integral method has been modified by including leading terms for steady 3-dimensional effects on a high aspect ratio rotating blade. A summary is presented of the

approach made, and a first set of results are compared with wind-tunnel data for a wind-turbine model. (author)

6557 (ETSU-N–125, [pp. 8]) **Investigation of teeter stability of stalled rotors.** Rawlinson-Smith, R. (Garrad, Hassan and Partners, Bristol (United Kingdom)). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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This study aims to improve understanding of the physics of teeter response in stalled Horizontal Axis Wind Turbines (HAWTs), and to provide a detailed set of data describing the teeter damping of two model rotors. Experimental results show only small variations in the level of damping which is positive for all conditions. However the inclusions of dynamic inflow and stall hysteresis does not give any significant improvement. (UK)

6558 (ETSU-N–125, [pp. 12]) **Some recent activities at FFA.** Ronsten, G. (Aeronautical Research Inst. of Sweden, Bromma (Sweden)); Dahlberg, J.-A. AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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Recent research activities at Sweden's Aeronautical Research Institute (the FFA) are described in this article. Wall interference corrections are presented for a Horizontal Axis Wind Turbine (HAWT) in a wind tunnel. Pressure measurements on the blade surface are evaluated. Wind tunnel tests on a yaw controlled HAWT are reported. Tests on a Danwin 180 kW HAWT include the effects of turbulence intensity and wind gradient, and normal stop loading compared to stall induced vibrations. (UK)

6559 (ETSU-N–125, [pp. 14]) **On the selection of optimum power coefficient for wind turbines with consideration of the thrust.** Bjoerck, A. (Aeronautical Research Inst. of Sweden, Bromma (Sweden)). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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In a wind farm, wind turbines standing in the wake of other turbines will produce less energy. Wake loss depends on the thrust of the turbine causing the wake. In this study, two "paper turbines" are designed to consider the energy capture needed to produce optimum deceleration and turbines with reduced chords. (UK)

6560 (ETSU-N–125, [pp. 26]) **Airfoil characteristics from a rotating wind turbine blade.** Bruining, A. (Delft Univ. of Technology (Netherlands). Inst. for Wind Energy). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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To determine the airfoil characteristics of a rotating wind turbine blade, pressure measurements have been carried out on a 10m diameter rotor with pressure taps on four span wise locations. The rotor was tested on the Rotor Research Facility of the Institute for Wind Energy of Delft University of Technology. (author)

6561 (ETSU-N–125, [pp. 16]) **Aerodynamic pressure measurements from a rotating S809 airfoil on a 10m diameter 3-bladed downwind HAWT.** Simms, D. (National Renewable Energy Lab., Golden, CO (United States)). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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Aerodynamic pressure measurements on a rotating airfoil in a horizontal axis wind turbine were carried out at the National Renewable Energy Laboratory (NREL) in Colorado. The study concentrates on unsteady aerodynamic effects. Results on the NREL machine were presented in video format. (UK)

6562 (ETSU-N–125, [pp. 12]) **Unsteady flow past wind turbine rotor.** Soerensen, J.N. (Danmarks Tekniske Hoejskole, Lyngby (Denmark). Afd. for Fluid Mekanik); Kock, C.W. AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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To study wind turbines operating in unsteady conditions an actuator disc model has been developed. The model is based on a finite difference discretization of the unsteady, axi-symmetric Euler equations in which the influence of the rotor on the flow field is modelled by replacing the blades by volume forces. These are obtained from tabulated airfoil data distributed evenly on the blade elements. Recently this model has been refined. A transformation allowing the grid to be axially and radially stretched has been implemented and the Euler equations have been replaced by the Navier-Stokes equations by introducing diffusive terms. This stabilizes the numerics and allows small-scale turbulence to be modelled by a mixing-length turbulence model. Finally, the previously employed first order accurate upwinding scheme has been replaced by a second order accurate one. In the following paper, the mathematical model is described and results showing the model's ability of describing unsteady flows are presented. (author)

6563 (ETSU-N–125, [pp. 16]) **Experiences in airfoil analysis and design.** Madsen, H.A. (Risoe National Lab., Roskilde (Denmark). Test Station for Wind Turbines); Rasmussen, F. AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the aerodynamics of wind turbines.* 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

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Results of the development/implementation of different tools for the design of optimized stall regulated wind turbine rotors are described in this paper. The design of an optimized wind turbine rotor can be separated into several processes, the specification of main data and constraints for the rotor (e.g. rated power, max. rotor diameter, max./min. rotational speed, etc.) the derivation of target airfoil characteristics, the design of airfoils with the desired characteristics and the analysis of the designed airfoils and the corresponding characteristics of the optimized rotor. The present paper concentrates on the second and fourth items with particular emphasis on comparing analysis results from different airfoil codes. The influence of uncertainty in predicting the airfoil C_L and C_D characteristics on the rotor characteristics is also considered. (author)

6564 (ETSU-N–125, [pp. 5]) **Response predictions in stall.** Rasmussen, F. (Risoe National Lab., Roskilde (Denmark). Test Station for Wind Turbines). AEA Environment and Energy, Harwell (United Kingdom); International Energy Agency (IEA), 75 - Paris (France). Mar 1993. (CONF-9211277–: 6. IEA symposium on the aerodynamics of wind turbines, Petten (Netherlands), 30 Nov - 1 dec 1992). In *Proceedings of the sixth IEA symposium on the*

aerodynamics of wind turbines. 215p. Order Number DE94725270. Source: OSTI; NTIS (US Sales Only).

IEA R and D WECS experts meeting.

Response predictions for stalled operation of wind turbine blades has been associated with much uncertainty as these normally will result in limit cycle oscillations when assuming steady 2-dimensional profile data. However, incorporation of a dynamic stall model makes it possible to create so much aerodynamic damping that the response can be controlled to realistic values comparable to measurements. This problem is being investigated in a common JOULE project "Stall induced vibrations" in which measurements and predictions on four stall regulated turbines are compared. Parallel to this, investigations have been performed on a 300 kW BONUS turbine at Riso using the code FLEX4. Results that aim at a clarification of the present status of response predictions in stall are presented in this paper. (author)

6565 (ETSU-WN–6056/016) **Separation distances for siting wind turbines: a literature survey.** Taylor, D. Altechnica, Milton Keynes (United Kingdom). 1992. 25p. Sponsored by AEA Environment and Energy, Harwell (United Kingdom). Order Number DE94730469. Source: OSTI; NTIS (US Sales Only).

The aim of this survey is to attempt to identify appropriate separation distances recommended in the literature designed to minimise the environmental impact likely to result from the siting of wind turbines. Information on wind turbine separation distances has been obtained from Denmark, the Netherlands, Germany, the USA and the UK. This largely takes the form of cautionary suggested separation zones and includes those derived from noise controls or local controls and permits that apply to building development in general except for the legal separation distances (known as "setbacks") required in some counties in the USA. (author)

6566 (SAND–93-1900) **User's guide for the frequency domain algorithms in the LIFE2 fatigue analysis code.** Sutherland, H.J. (Sandia National Labs., Albuquerque, NM (United States)); Linker, R.L. Sandia National Labs., Albuquerque, NM (United States); New Mexico Engineering Research Inst., Albuquerque, NM (United States). Oct 1993. 53p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94004678. Source: OSTI; NTIS; GPO Dep.

The LIFE2 computer code is a fatigue/fracture analysis code that is specialized to the analysis of wind turbine components. The numerical formulation of the code uses a series of cycle count matrices to describe the cyclic stress states imposed upon the turbine. However, many structural analysis techniques yield frequency-domain stress spectra and a large body of experimental loads (stress) data is reported in the frequency domain. To permit the analysis of this class of data, a Fourier analysis is used to transform a frequency-domain spectrum to an equivalent time series suitable for rainflow counting by other modules in the code. This paper describes the algorithms incorporated into the code and their numerical implementation. Example problems are used to illustrate typical inputs and outputs.

1707 Health and Safety

6567 (ECN-RX–93-103) **Reliability analysis in wind turbine engineering.** Seebregts, A.J.; Rademakers, L.W.M.M.; Van den Horn, B.A. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Sep 1993. 9p. Order Number DE94729851. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

To be presented at the Dutch Chapter of SRE/Dutch Reliability Society (NVvB) Symposium, Arnhem, Netherlands, 4-6 October 1993.

Wind turbines are being designed in accordance with deterministic design rules. As wind turbines increase in size and power, these rules may not be adequate to ascertain a safe and well balanced design. Wind turbine industry can take advantage of the safety and reliability practices in e.g. aerospace, nuclear and offshore industry. These practices include System Reliability and Structural Reliability methods. The approach to introduce Probabilistic Safety Assessment (PSA), which incorporates these reliability methods, into wind turbine engineering, are described. The applicability, benefits and limitations of these methods are illustrated by means of two recent case studies. 5 figs., 2 tabs., 24 refs.

20 FOSSIL-FUELED POWER PLANTS

2001 Power Plants and Power Generation

Refer also to citation(s) 6021, 6039, 6054, 6425, 7187

6568 (DOE/EIA–0095(92)) **Inventory of Power Plants in the United States, October 1992.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. 27 Oct 1993. 404p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94002519. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

The Inventory of Power Plants in the United States is prepared annually by the Survey Management Division, Office of Coal, Nuclear, Electric and Alternate Fuels, Energy Information Administration (EIA), US Department of Energy (DOE). The purpose of this publication is to provide year-end statistics about electric generating units operated by electric utilities in the United States (the 50 States and the District of Columbia). The publication also provides a 10-year outlook of future generating unit additions. Data summarized in this report are useful to a wide audience including Congress, Federal and State agencies, the electric utility industry, and the general public. Data presented in this report were assembled and published by the EIA to fulfill its data collection and dissemination responsibilities as specified in the Federal Energy Administration Act of 1974 (Public Law 93-275) as amended. The report is organized into the following chapters: Year in Review, Operable Electric Generating Units, and Projected Electric Generating Unit Additions. Statistics presented in these chapters reflect the status of electric generating units as of December 31, 1992.

6569 (DOE/MC/21023–94/C0271) **The advanced PFB process: Pilot plant results and design studies.** Robertson, A. (Foster Wheeler Development Corp., Livingston, NJ (United States)); Domeracki, W.; Horazak, D.; Newby, R.; Rehmat, A. Foster Wheeler Development Corp., Livingston, NJ (United States). [1993]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-86MC21023. (CONF-931094–1: 12. coal gasification power plants conference, San Francisco, CA (United States), 27-29 Oct 1993). Order Number DE94002959. Source: OSTI; NTIS; GPO Dep.

The plant being developed is a hybrid of two technologies; it incorporates the partial gasification of coal in a vessel called the carbonizer and the combustion of the resultant char residue in a circulating pressurized fluidized bed combustor (CPFBC). In this plant, coal is fed to a pressurized carbonizer that produces a low-Btu fuel gas and char. After passing through a cyclone and a ceramic barrier filter to remove gas-entrained particulates, the fuel gas is burned in a topping combustor to produce the energy required to drive a gas turbine. The gas turbine drives a generator and a compressor that feeds air to the carbonizer, a CPFBC, and a fluidized bed heat exchanger (FBHE). The carbonizer char is burned in the CPFBC with high excess air. The vitiated air from the CPFBC supports combustion of the fuel gas in the gas turbine topping combustor. Steam generated in a heat-recovery steam generator (HRSG) downstream of the gas turbine and in the FBHE associated with the CPFBC drives the steam turbine generator that furnishes the balance of electric power delivered by the plant. The low-Btu gas is produced in the carbonizer by pyrolysis/mild devolatilization of coal in a fluidized bed reactor. Because this unit operates at temperatures much lower than gasifiers currently under development, it also produces a char residue. Left untreated, the fuel gas will contain hydrogen sulfide and sulfur-containing tar/light oil vapors; therefore, lime-based sorbents are injected into the carbonizer to catalytically enhance tar cracking and to capture sulfur as calcium sulfide. Sulfur is captured in situ, and the raw fuel gas is fired hot. Thus the expensive, complex, fuel gas heat exchangers and the chemical or sulfur-capturing bed cleanup systems that are part of the coal gasification combined-cycle plants now being developed are eliminated.

6570 (DOE/MC/21023–3525) **Second-generation pressurized fluidized bed combustion plant: Conceptual design and optimization of a second-generation PFB combustion plant: Annual report, October 1, 1991–September 30, 1992.** Robertson, A.; Domeracki, W.; Newby, R.; Rehmat, A.; Horazak, D. Foster Wheeler Development Corp., Livingston, NJ (United States). Oct 1992. 92p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-86MC21023. Order Number DE94000050. Source: OSTI; NTIS; GPO Dep.

After many years of experimental testing and development work, coal-fired pressurized fluidized bed (PFB) combustion combined-cycle power plants are moving toward reality. Under the U.S Department of Energy's Clean Coal Technology Program, a 70-MWe PFB combustion retrofit, utilizing a 1525°F gas turbine inlet temperature, is to be built as a demonstration plant at the American Electric Power Company's Tidd Plant in Brilliant, Ohio. As PFB combustion technology moves closer and closer to commercialization, interest is turning toward the development of an even more efficient and more cost-effective PFB combustion plant. The targeted goals of this "second-generation" plant are a 45-percent efficiency and a cost of electricity (COE) that is at least 20 percent lower than the COE of a conventional pulverized-coal (PC)-fired plant with stack gas scrubbing. In addition, plant emissions should be within New Source Performance Standards (NSPS) and the plant should have high availability, be able to burn different ranks of coal, and incorporate modular construction technologies.

6571 (DOE/MC/23165–94/C0242) **Direct coal-fired gas turbines for combined cycle plants.** Rothrock, J.; Wenglarz, R.; Hart, P.; Mongia, H. General Motors Corp., Indianapolis, IN (United States). Allison Gas Turbine Div. [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-86MC23165. (CONF-930893–21: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94002969. Source: OSTI; NTIS; GPO Dep.

The combustion/emissions control island of the CFTCC plant produces cleaned coal combustion gases for expansion in the gas turbine. The gases are cleaned to protect the turbine from flow-path degeneration due to coal contaminants and to reduce environmental emissions to comparable or lower levels than alternate clean coal power plant tedmologies. An advantage of the CFTCC system over other clean coal technologies using gas turbines results from the CFTCC system having been designed as an adaptation to coal of a natural gas-fired combined cycle plant. Gas turbines are built for compactness and simplicity. The RQL combustor is designed using gas turbine combustion technology rather than process plant reactor technology used in other pressurized coal systems. The result is simpler and more compact combustion equipment than for alternate technologies. The natural effect is lower cost and improved reliability. In addition to new power generation plants, CFTCC technology will provide relatively compact and gas turbine compatible coal combustion/emissions control islands that can adapt existing natural gas-fired combined cycle plants to coal when gas prices rise to the point where conversion is economically attractive. Because of the simplicity, compactness, and compatibility of the RQL combustion/emission control island compared to other coal technologies, it could be a primary candidate for such conversions.

6572 (DOE/MC/23166–94/C0236) **Gas fired advanced turbine system: Phase 1, System scoping and feasibility studies.** LeCren, R.T.; White, D.J. Solar Turbines, Inc., San Diego, CA (United States). Research Dept. [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-86MC23166. (CONF-930893–37: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94003193. Source: OSTI; NTIS; GPO Dep.

The basic concept thus derived from the Ericsson cycle is an intercooled, recuperated, and reheated gas turbine. Theoretical performance analyses, however, showed that reheat at high turbine rotor inlet temperatures (TRIT) did not provide significant efficiency gains and that the 50 percent efficiency goal could be met without reheat. Based upon these findings, the engine concept adopted as a starting point for the gas-fired advanced turbine system is an intercooled, recuperated (ICR) gas turbine. It was found that, at inlet temperatures greater than 2450°F, the thermal efficiency could be maintained above 50%, provided that the turbine cooling flows could be reduced to 7% of the main air flow or lower. This dual and conflicting requirement of increased temperatures and reduced cooling will probably force the abandonment of traditional air cooled turbine parts. Thus, the use of either ceramic materials or non-air cooling fluids has to be considered for the turbine nozzle guide vanes and turbine blades. The use of ceramic components for the proposed engine system is generally preferred because of the potential growth to higher temperatures that is available with such materials.

6573 (DOE/MC/23167–94/C0241) **Interface between a gas turbine and PFBC.** Bannister, R.L.; McGuigan, A.W.; Christenson, J.A.; Howell, I.L.; Marson, E.; Post, M.V.; Risley, R.P.; Vota, T.L. Westinghouse Electric Corp., Orlando, FL (United States). [1993]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-86MC23167. (CONF-930893–7: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94001922. Source: OSTI; NTIS; GPO Dep.

First-generation pressurized fluidized bed combustion (PFBC) technology has potential advantages that include lower capital cost, improved environmental performance, shorter lead times, higher efficiency, and enhanced fuel flexibility. The objective of this program is to ensure that combustion turbine designs stay current with PFBC technology, specifically to ensure that the Westinghouse 251B12 combustion turbine is suitable for demonstration phases of this technology as it progresses toward commercial deployment. This paper presents the preliminary design of system interfaces that permit combining a PFBC and a Westinghouse 251B12 combustion turbine.

6574 (DOE/MC/26041–94/C0256) **Air extraction in gas turbines burning coal-derived gas.** Yang, Tah-teh; Agrawal, A.K.; Kapat, J.S. Clemson Univ., SC (United States). [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-89MC26041. (CONF-930893–17: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94002965. Source: OSTI; NTIS; GPO Dep.

In the first phase of this contracted research, a comprehensive investigation was performed. Principally, the effort was directed to identify the technical barriers which might exist in integrating the air-blown coal gasification process with a hot gas cleanup scheme and the state-of-the-art, US made, heavy-frame gas turbine. The guiding rule of the integration is to keep the compressor and the expander unchanged if possible. Because of the low-heat content of coal gas and of the need to accommodate air extraction, the combustor and perhaps, the flow region between the compressor exit and the expander inlet might need to be modified. In selecting a compressed air extraction scheme, one must consider how the scheme affects the air supply to the hot section of the turbine and the total pressure loss in the flow region. Air extraction must preserve effective cooling of the hot components, such as the transition pieces. It must also ensure proper air/fuel mixing in the combustor, hence the combustor exit pattern factor. The overall thermal efficiency of the power plant can be increased by minimizing the total pressure loss in the diffusers associated with the air extraction. Therefore, a study of airflow in the pre- and dump-diffusers with and without air extraction would provide information crucial to attaining high-thermal efficiency and to preventing hot spots. The research group at Clemson University suggested using a Griffith diffuser for the prediffuser and extracting air from the diffuser inlet. The present research establishes that the analytically identified problems in the impingement cooling flow are factual. This phase of the contracted research substantiates experimentally the advantage of using the Griffith diffuser with air extraction at the diffuser inlet.

6575 (DOE/MC/26041–3533) **Identifying technology barriers in adapting a state-of-the-art gas turbine for IGCC applications and an experimental investigation of air extraction schemes for IGCC operations: Final report.** Yang, Tah-teh;

Agrawal, A.K.; Kapat, J.S. Clemson Univ., SC (United States). Dept. of Mechanical Engineering. Jun 1993. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-89MC26041. Order Number DE94000058. Source: OSTI; NTIS; GPO Dep.

Under contracted work with Morgantown Energy Technology Center, Clemson University, the prime contractor, and General Electric (GE) and CRSS, the subcontractors, made a comprehensive study in the first phase of research to investigate the technology barriers of integrating a coal gasification process with a hot gas cleanup scheme and the state-of-the-art industrial gas turbine, the GE MS-7001F. This effort focused on (1) establishing analytical tools necessary for modeling combustion phenomenon and emissions in gas turbine combustors operating on multiple species coal gas, (2) estimates the overall performance of the GE MS-7001F combined cycle plant, (3) evaluating material issues in the hot gas path, (4) examining the flow and temperature fields when air extraction takes place at both the compressor exit and at the manhole adjacent to the combustor, and (5) examining the combustion/cooling limitations of such a gas turbine by using 3-D numerical simulation of a MS-7001F combustor operated with gasified coal. In the second phase of this contract, a 35% cool flow model was built similar to GE's MS-7001F gas turbine for mapping the flow region between the compressor exit and the expander inlet. The model included sufficient details, such as the combustor's transition pieces, the fuel nozzles, and the supporting struts. Four cases were studied: the first with a base line flow field of a GE 7001F without air extraction; the second with a GE 7001F with air extraction; and the third and fourth with a GE 7001F using a Griffith diffuser to replace the straight wall diffuser and operating without air extraction and with extraction, respectively.

6576 (DOE/MC/29061–94/C0239) **Industry/University Consortium for ATS research.** Allen, R.P.; Golan, L.P. South Carolina Energy Research and Development Center, Clemson, SC (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-92MC29061. (CONF-930893–40: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94003194. Source: OSTI; NTIS; GPO Dep.

The Industry/University ATS research program is the result of two planning workshops. Workshop I was held April 8–10, 1991 and had the goal of identifying research needs for advanced gas turbine cycles that would permit rapid commercialization of cycles with significant improvements over the machines currently under development, in terms of the cost of electricity produced and the environmental burdens resulting from their use in power producing. Workshop II was held in January 1992 and continued the identification of the research needs to develop advanced gas turbine systems. The goals established for the ATS systems were: (1) efficiency exceeding 60% for large utility turbine system and 15% improvement in heat rate for industrial systems; (2) busbar energy costs 10% less than current state of the art and (3) fuel flexible designs. In addition Workshop II participants agreed that an industry driven research consortium was an acceptable mechanism to achieve base technology development needs.

6577 (DOE/METC–93/6132) **Proceedings of the joint contractors meeting: FE/EE Advanced Turbine Systems conference FE fuel cells and coal-fired heat engines conference.** Geiling, D.W. (ed.). USDOE Morgantown Energy Technology Center, WV (United States). Aug 1993. 499p. Sponsored by USDOE, Washington, DC (United States). (CONF-930893–: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE93011308. Source: OSTI; NTIS; GPO Dep.

The joint contractors meeting: FE/EE Advanced Turbine Systems conference FEE fuel cells and coal-fired heat engines conference; was sponsored by the US Department of Energy Office of Fossil Energy and held at the Morgantown Energy Technology Center, P.O. Box 880, Morgantown, West Virginia 26507-0880, August 3–5, 1993. Individual papers have been entered separately.

6578 (DOE/METC/C–94/7106) **Pressure-gain combustion.** Richards, G.A. (USDOE Morgantown Energy Technology Center, WV (United States)); Yip, J.; Gemmen, R.S.; Janus, M.C.; Norton, T.; Rogers, W.A. USDOE Morgantown Energy Technology Center, WV (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). (CONF-930893–39: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94002975. Source: OSTI; NTIS; GPO Dep.

Pulse combustion has been proposed for gas turbine applications in many early articles and more recently has been demonstrated to produce so-called "pressure-gain" in a small gas turbine. The basic concept is that the oscillatory combustion occurs as a constant-volume process, producing a gain in the stagnation pressure of air flowing through the combustor, rather than the pressure loss associated with conventional, steady combustion. If properly utilized, this pressure-gain could enhance simple-cycle gas turbine efficiency several percent, depending on the operating conditions. In addition, pulse combustors have demonstrated relatively low NO_x pollutant levels in some applications. The combined potential for higher cycle efficiency and lower pollutant levels is the basis for the present investigation. Tests in progress at the Morgantown Energy Technology Center (METC) have considered a baseline pulse combustor configuration that has shown good oscillating performance, low NO_x emissions, but disappointing results in terms of pressure-gain. However, a combination of numeric simulations and test data suggest that pressure-gain can be produced by a select combination of operating conditions and combustor geometry, but is especially sensitive to the combustor inlet geometry. Tests in progress will evaluate the effect of inlet geometry and operating pressure on both pollutant emissions and pressure-gain.

6579 (EDF–93-NB-00086) **Heat transfer in a 125 MWe CFB boiler.** Jestin, L.; Meyer, P.; Schmitt, G. Electricite de France (EDF), 92 - Clamart (France). Mar 1992. 12p. (In French). Order Number DE94728745. Source: OSTI; NTIS (US Sales Only).

A heat fluxmeter has been developed to investigate the heat transfer mechanisms inside a furnace of a CFB (circulating fluidized bed), without disturbing the local hydrodynamics. The first results from a 125 MWe CFB provide some trends in flux differences at various locations. (author). 13 refs., 12 figs.

6580 (EDF–93-NB-00101) **Heat transfer measurement and analysis in a 125 MWe circulating fluidized bed boiler.** Montat, D.; Schmitt, G.; Piedfer, O.; Arhaliass, A.; Jestin, L. Electricite de France (EDF), 92 - Clamart (France). Jun 1993. 11p. (In French). Order Number DE94728749. Source: OSTI; NTIS (US Sales Only).

EDF research program on circulating fluidized beds includes, besides mock-up studies and numerical codes development, on-site measurements at Emile Huchet 125 MWe power station (in Carling). This publication concerns the last results obtained on dynamic heat transfer measurements. A method to solve the inverse heat conduction problem in the furnace wall, allowing the computation of the dynamic heat transfer coefficient at the wall from temperature measurements in this wall, has been developed. The analysis of the results obtained yields new insights on the effect of gas-solid mixing near the walls on heat transfer mechanisms. In order to improve this analysis, local concentration measurements are needed. A system for particle concentration measurement, using an optical probe, a video camera and an image processing system, is currently under development and will be set up in the riser of Emile Huchet power station. (author). 16 refs., 11 figs.

6581 (ENEA-RT-AMB–92-04) **Micropollutants emission from refuse derived fuel combustion.** Di Palo, C. (ENEA, Casaccia (Italy). Area Energia Ambiente e Salute); Coronidi, M.; Zagaroli, M.; Zamora, P. No corporate text available. Mar 1993. 14p. (RT/AMB–92-04). Order Number DE94727344. Source: OSTI; NTIS (US Sales Only).

In this work, fly ash and solid residues produced by an incinerator of Refuse Derived Fuel (RDF) have been analyzed for polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) and heavy metals. Furthermore, the content of that species in the fly ash and the concentration of hydrochloric acid and particulate in the gas stream have been tested before and after the flue gas treatment system (wet scrubbing type) to determine the efficiency of the system. Chemical analysis of the extracts have been performed by high resolution gas chromatography with

mass-spectrometric detector (GC-MS) and atomic absorption spectroscopy. A description of the incinerator plant and of the flue gas treatment system is presented. The results are critically discussed.

6582 (LIU-TEK-LIC–93-18) **Dynamics of composite rotors, with special reference to influence of imperfections and internal damping.** Linkoeping Studies in Science and Technology, 376. Svensson, Haakan. Linkoeping Univ. (Sweden). Dept. of Mechanical Engineering. 1993. 129p. Order Number DE94730423. Source: OSTI; NTIS.

In this thesis two aspects on rotors made from composite materials have been treated. The first major aspect is that due to centrifugal forces imperfection of thin-walled shafts will lead to changes in the geometry. This study shows that the change in the stiffness due to an imperfection has much greater influence than a change in the geometry. Imperfection of the types treated in here have largest influence when the filament winding angle is about 60 degrees. The only terms that largely influence the behaviour of a rotor in a Fourier Series expansion of the deformed contour due to an imperfection, are the three first. The second aspect is that for classical rotor materials the influence of material damping can mostly be neglected. For composites, however, the damping can be one to two orders of magnitude larger. This study shows how hysteretic material damping can be analyzed by using a viscous damping model, where the damping constant is depending on the frequency. An instability criterion for various conditions of shafts and bearings are given. It is shown that the combined effects of fluid film bearings and internal damping has to be taken under account in analyses of composite shafts mounted on fluid film bearings. The material damping for a high-modulus carbon fiber in a epoxy resin has been investigated for different filament winding angles. the separate contributions on the damping from the stresses in the directions of the fibre, transverse to the fibres and in shear has been taken into account. Finally, this study shows that the optimal filament winding angle interval to get as low weight as possible for three different constraints, lateral eigenfrequency, maximum torque due to static stress and maximum torque due buckling, is in the same interval as the optimal filament winding angle to get as low dissipation energy as possible. 15 refs, 49 figs

6583 (NUTEK-VK–93-16) **Displacement expanders for small scale cogeneration.** Platell, P. (Royal Inst. of Tech., Stockholm (Sweden). Dept. of Machine Design). Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden); Royal Inst. of Tech., Stockholm (Sweden). Dept. of Machine Design. 1993. 128p. Project NUTEK-566-025. (TRITA-MAK-LA–93-1). Order Number DE94730430. Source: OSTI; NTIS.

The objective of this thesis work has been to investigate the potential for positive displacement (or volumetric) types of expansion machines for the application in small scale cogeneration as alternatives to conventional turbo expanders. Major design parameters have been identified, and fairly generalized relation between design parameters and operational, application-specific, parameters have been established for various types of volumetric expanders. Rotary displacement expanders and the Lysholm twin-screw type in particular, as well as piston type expanders have been analyzed. This study has been concentrated on thermodynamic performance related to design parameters, and also on mechanical design aspects and constraints. The possibilities for direct drive of high-speed, high frequency generators, have also been considered. Analytical expressions for performance evaluation, based on major design parameters, have been derived. For the screw expander, also a more detailed model for computer simulation has been developed. Simulation results have been used for a generalized performance prediction for screw expanders, independent of machine size. Due to mechanical limitations and increased internal leakage at higher pressures, the screw expander should be limited to roughly 40 bar. For low/medium temperature expander applications, the screw machine application should then be straight-forward. In a 40 bar saturated steam cycle, the total efficiency should be limited to roughly 15-20%. Piston machines have a potential for high-pressure applications and improved efficiency particularly at part load. For expansion of steam, with 200 bar, 500 centigrade admission, a total efficiency of roughly 30% should be possible at part load. However, several problems remain to be solved, e.g. concerning tribology and lubrication, valve design, materials selection, etc. 35 refs, 70 figs, 3 tabs

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Refer also to citation(s) 6020, 6058, 6573, 7066

6584 (ANL/ES/CP–81389) **Recovery, transport, and disposal of CO_2 from an integrated gasification combined-cycle power plant.** Livengood, C.D.; Doctor, R.D.; Molburg, J.C.; Thimmapuram, P.; Berry, G.F. Argonne National Lab., IL (United States). [1993]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931116–1: Power-Gen Americas: 6th international power generation exhibition and conference, Dallas, TX (United States), 16-18 Nov 1993). Order Number DE94004571. Source: OSTI; NTIS; GPO Dep.

Initiatives to limit CO_2 emissions have drawn considerable interest to integrated gasification combined-cycle (IGCC) power generation, a process that reduces CO_2 production and is amenable to CO_2 capture. This paper presents a comparison of energy systems that encompass fuel supply, an IGCC system, CO_2 recovery using commercial technologies, CO_2 transport by pipeline, and land-based sequestering in geological reservoirs. The intent is to evaluate the energy efficiency impacts of controlling CO_2 in such a system, and to provide the CO_2 budget, or an equivalent CO_2 budget, associated with each of the individual energy-cycle steps. The value used for the equivalent CO_2 budget is 1 kg CO_2/kWh. The base case for the comparison is a 458-MW IGCC system using an air-blown Kellogg Rust Westinghouse (KRW) agglomerating fluidized-bed gasifier, Illinois No.6 bituminous coal, and in-bed sulfur removal. Mining, transportation, and preparation of the coal and limestone result in a net electric power production of 448 MW with a 0.872 kg/kWh CO_2 release rate. For comparison, the gasifier output was taken through a water-gas shift to convert CO to CO_2, and processed in a Selexol unit to recover CO_2 prior to the combustion turbine. A 500-km pipeline then took the CO_2 to geological sequestering. The net electric power production was 383 MW with a 0.218 kg/kWh CO_2 release rate.

6585 (DOE/PC/89651–T10) **Performance and operating results from the demonstration of advanced combustion techniques for wall-fired boilers.** Sorge, J.N. (Southern Co. Services, Inc., Birmingham, AL (United States)); Baldwin, A.L. Southern Co. Services, Inc., Birmingham, AL (United States). [1993]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89651. (CONF-9309152–1: 2. annual clean coal technology conference, Atlanta, GA (United States), 7-9 Sep 1993). Order Number DE94001957. Source: OSTI; NTIS; GPO Dep.

This paper discusses the technical progress of a US Department of Energy Innovative Clean Coal Technology project demonstrating advanced wall-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from coal-fired boilers. The primary objective of the demonstration is to determine the long-term performance of advanced overfire air and low NO_x burners applied in a stepwise fashion to a 500 MW boiler. A 50 percent NO_x reduction target has been established for the project. The focus of this paper is to present the effects of excess oxygen level and burner settings on NO_x emissions and unburned carbon levels and recent results from the phase of the project when low NO_x burners were used in conjunction with advanced overfire air.

6586 (DOE/PC/89651–T11) **Innovative Clean Coal Technology (ICCT): 500 MW demonstration of advanced wall-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from coal-fired boilers: Technical progress report: First quarter 1993.** Southern Co. Services, Inc., Birmingham, AL (United States). [1993]. 72p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89651. Order Number DE94005036. Source: OSTI; NTIS; GPO Dep.

This quarterly report discusses the technical progress of an Innovative Clean Coal Technology (ICCT) demonstration being conducted at Georgia Power Company's Plant Hammond Unit 4 located near Rome, Georgia. The primary goal of this project is the characterization of the low NO_x combustion equipment through the

collection and analysis of long-term emissions data. A target of achieving fifty percent NO_x reduction using combustion modifications has been established for the project. The project provides a stepwise retrofit of an advanced overfire air (AOFA) system followed by low NO_x burners (LNB). During each test phase of the project, diagnostic, performance, long-term, and verification testing will be performed. These tests are used to quantify the NO_x reductions of each technology and evaluate the effects of those reductions on other combustion parameters such as particulate characteristics and boiler efficiency. During this quarter, long-term testing of the LNB + AOFA configuration continued and no parametric testing was performed. Further full-load optimization of the LNB + AOFA system began on March 30, 1993. Following completion of this optimization, comprehensive testing in this configuration will be performed including diagnostic, performance, verification, long-term, and chemical emissions testing. These tests are scheduled to start in May 1993 and continue through August 1993. Preliminary engineering and procurement are progressing on the Advanced Low NOx Digital Controls scope addition to the wall-fired project. The primary activities during this quarter include (1) refinement of the input/output lists, (2) procurement of the distributed digital control system, (3) configuration training, and (4) revision of schedule to accommodate project approval cycle and change in unit outage dates.

6587 (DOE/PC/89655–T9) **SNOX demonstration project: 13th Quarterly technical progress report, January–March 1993.** ABB Environmental Systems, Birmingham, AL (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89655. Order Number DE94004550. Source: OSTI; NTIS; GPO Dep.

This is a description of the activities of the SNOX project for the months Jan-Mar, 1993. Operation and testing continued under Phase III of the program. Following testing of the Selective Catalytic Reduction NO_x removal portion of the system at the end of the quarter, all major equipment has been tested and characterized. This will allow fine tuning of the system in preparation for a two month optimized run. The report presents a summary of the running time of the system during this period, of the systems which were tested and/or repaired or replaced during this period, and of the amount of sulfuric acid which was shipped from the plant during this period.

6588 (DOE/PC/89659–T14) **Coal reburning for cyclone boiler NO_x control demonstration: Quarterly report No. 13, April–June 1993.** Babcock and Wilcox Co., Alliance, OH (United States). 15 Sep 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89659. Order Number DE94003600. Source: OSTI; NTIS; GPO Dep.

The coal reburning for cyclone boiler NO_x control system consists of commercially available equipment, such as a pulverizer, burners, a pneumatic coal transfer system, overfire air ports and a control system, all of which are well proven, reliable equipment that can be readily installed. Extensive power plant modification is not required to implement the reburn technology which will increase the potential for commercialization. The coal reburning technology will be a desirable alternative for cyclone boiler NO_x control by offering: (1) A technically and economically feasible low-NO_x alternative for cyclone boilers to achieve a 50% to 60% NO_x reduction where one currently does not exist. (2) Significant reductions in emission-levels of oxides of nitrogen achieved at a low capital cost and very low operating costs (compared to the SCR technology). (3) No need for a supplemental fuel. Reburn will be carried out using the present boiler fuel which is coal. (4) A system that will maintain boiler reliability, operability, and steam production performance after retrofit. The coal reburning for cyclone boiler NO_x control demonstration project will be carried out at the Nelson Dewey Station Unit No. 2 of Wisconsin Power and Light in Cassville, Wisconsin.

6589 (DOE/PC/90361–T11) **Catalytic fabric filtration for simultaneous NO_x and particulate control: Quarterly technical progress report, April 1–June 30, 1993.** Weber, G.F.; Ness, S.R.; Laudal, D.L.; Dunham, G.E. North Dakota Univ., Grand Forks, ND (United States). Energy and Environmental Research Center. Aug 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-90PC90361. Order Number DE94001660. Source: OSTI; NTIS; GPO Dep.

The University of North Dakota Energy & Environmental Research Center (EERC), Owens-Corning Fiberglas Corporation (OCF), and Raytheon Engineers & Constructors (RE&C), are conducting research to develop a catalytic fabric filter (CFF) for simultaneous NO_x and particulate control. Advances at OCF have shown that a high-activity catalyst can be applied to a high-temperature woven glass cloth resulting in a fabric filter material that can operate at temperatures higher than commercially available, coated glass fabric. The NO_x is removed by catalytic reduction with ammonia to form nitrogen and water. The catalyst employed at this time is vanadium/titanium, but the exact catalyst composition and the unique method of applying the catalyst to high-temperature glass fabric are the property of OCF. Other catalyst options are being evaluated by OCF in order to improve catalyst performance and minimize catalyst cost. Bench-scale experimental results have shown that over 90% NO_x removal can be achieved, that the catalyst/fabric has promising self-abrasion characteristics, and that the potential exists for substantially reduced cost compared to conventional SCR/fabric filtration technology. However, development of the technology requires further evaluation of air-to-cloth ratio effects, ammonia slip, SO_2 oxidation to SO_3, temperature cycling, catalyst-coated fabric preparation, fuel impacts, fabric cleaning (reverse-gas versus pulse-jet), catalyst life (poisoning and resistance to erosion), and filter performance/life (particulate control, differential pressure, and durability).

6590 (DOE/PC/90546–T10) **Confined zone dispersion flue gas desulfurization demonstration: Quarterly report No. 9, November 17, 1992–February 16, 1993.** Bechtel Corp., San Francisco, CA (United States). 1 Oct 1993. 155p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-91PC90546. Order Number DE94002403. Source: OSTI; NTIS; GPO Dep.

The CZD process involves injecting a finely atomized slurry of reactive lime into the flue gas duct work of a coal-fired utility boiler. The principle of the confined zone is to form a wet zone of slurry droplets in the middle of the duct confined in an envelope of hot gas between the wet zone and the duct walls. The lime slurry reacts with part of the SO_2 in the gas, and the reaction products dry to form solid particles. A solids collector, typically on electrostatic precipitator (ESP) downstream from the point of injection, captures the reaction products along with the fly ash entrained in the flue gas. The waste product is composed of magnesium and calcium sulfite and sulfate, with some excess lime. This product mixed with fly ash is self-stabilizing because of the excess lime values, and thus tends to retain heavy metals in insoluble forms within the fly ash. The demonstration is being conducted at Penelec's Seward Station, Unit No. 15. This boiler is a 147 MWe coal-fired unit, which utilizes Pennsylvania bituminous coal (approximately 1.2 to 2.5% sulfur). Progress is described for the ninth quarter.

6591 (DOE/PC/90546–T11) **Confined zone dispersion flue gas desulfurization demonstration: Quarterly report No. 10, February 17–May 31, 1993.** Bechtel Corp., San Francisco, CA (United States). 15 Nov 1993. 239p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-91PC90546. Order Number DE94005048. Source: OSTI; NTIS; GPO Dep.

The CZD process involves injecting a finely atomized slurry of reactive lime into the flue gas duct work of a coal-fired utility boiler. The principle of the confined zone is to form a wet zone of slurry droplets in the middle of the duct walls. The lime slurry reacts with part of the SO_2 in the gas, and the reaction products dry to form solid particles. A solids collector, typically an electrostatic precipitator (ESP) downstream from the point of injection, captures the reaction products along with the fly ash entrained in the flue gas. The demonstration is being conducted at Penelec's Seward Station, Unit No. 15. This boiler is a 147 MWe coal-fired unit, which utilizes Pennsylvania bituminous coal (approximately 1.2 to 2.5% sulfur). One of the two flue gas ducts leading from the boiler has been retrofitted with the CZD technology. The first existing ESP installed in the station is immediately behind the air preheater. The second ESP, installed about 15 years ago, is about 80 feet away from the first ESP. The goal of this demonstration is to prove the

technical and economic feasibility of the CZD technology on a commercial scale. The process is expected to achieve 50% SO_2.

6592 (DOE/PC/91346–3) **Development of the integrated environmental control model: Performance models of selective catalytic reduction NO_x control systems: Quarterly progress report, [April 1, 1993–June 30, 1993].** Frey, H.C. Carnegie-Mellon Univ., Pittsburgh, PA (United States). Center for Energy and Environmental Studies. Jul 1993. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC91346. Order Number DE94002151. Source: OSTI; NTIS; GPO Dep.

This report concerns the Integrated Environmental Control Model (IECM) created and enhanced by Carnegie Mellon University (CMU) for the US Department of Energy's Pittsburgh Energy Technology Center (DOE/PETC). The IECM provides a capability to model various conventional and advanced processes for controlling air pollutant emissions from coal-fired power plants before, during, or after combustion. The principal purpose of the model is to calculate the performance, emissions, and cost of power plant configurations employing alternative environmental control methods. The model consists of various control technology modules, which may be integrated into a complete utility plant in any desired combination. In contrast to conventional deterministic models, the IECM offers the unique capability to assign probabilistic values to all model input parameters, and to obtain probabilistic outputs in the form of cumulative distribution functions indicating the likelihood of different costs and performance results.

6593 (DTH-LBM-TR–92-266) **Pozzolanic reaction in fly ash: Project report.** Brunnstroem Jensen, J. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Bygningsmaterialer. 1992. 122p. (In Danish). Order Number DE94730340. Source: OSTI; NTIS.

The aim was to describe the pozzolanic reaction (reaction with calcium hydroxide) of fly ash. The description is based on theoretical and hardening reactions in the cement/fly ash system. Tests were made on cement paste, v/c 0.45, cement/fly ash paste with same original porosity as for cement paste and 30% fly ash (FA/Ce-weight conditions 0.30) and calcium hydroxide/fly-ash paste with the same fluid properties as cement paste and CH/FA- weight proportion 1.2. The cements' reaction and the combination of these reactions were also studied. The pastes' heat generation during hydration at 40 deg. centigrade and reduction of volume (at 20, 30 and 40 deg. centigrade) resulting from the state of the water during hydration were determined. In the case of cement/fly ash and calcium hydroxide/fly ash pastes the weight proportions between the components varied with the determination of volume reduction at 40 deg. centigrade - FA/Ce = 0.30, 0.45 and 0.60 CH/FA = 1.2, 0.8 and 0.4. It was also aimed to determine the various hydrating properties of fly ash. It was found that the pozzolanic reaction of fly ash follows linear kinetics in relation to the description of the dispersion model and that the cement/fly ash reaction could be understood as the sum of the time -staggered cement and fly ash reactions. The fly ash reaction is very slow and its activation energy is determined at 75 kJ/mol. Volume reduction was 10-19 ml/100g fly ash at 40 - 20 deg. centigrade, the maximum heat generation during the reaction was approximately 400 J/g fly ash. Results indicate that during the fly ash reaction, calcium silica hydrates and other hydrates are produced. (AB) (41 refs.)

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6594 (INIS-mf–13735) **Nuclear Safety Review 1991.** Bezpecnost Jadernych Zarizeni, no.2. Statni Urad pro Jadernou Bezpecnost, Prague (Czech Republic). 1993. 52p. Translation of pages D1-D49 of the IAEA Yearbook 1991. International Atomic Energy Agency, Vienna 1992. (In Czech). Order Number DE94610800. Source: OSTI; NTIS (US Sales Only); INIS.

A survey of IAEA activities in the field of nuclear safety with particular emphasis on the international cooperation in safety assessment of research reactors, early WWER type reactors is given. 12 tabs., 2 figs.

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 6696, 6704, 6706, 6707, 6724, 6729, 6730, 6734, 6736, 6737, 6738, 6739

6595 (DOE/SF/19681–T2) **Study of Pu consumption in Advanced Light Water Reactors: Evaluation of GE Advanced Boiling Water Reactor plants: Compilation of Phase 1B task reports.** General Electric Co., San Jose, CA (United States). 15 Sep 1993. 584p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-93SF19681. Order Number DE94000535. Source: OSTI; NTIS; INIS; GPO Dep.

This Phase 1B Report, discusses the results on key issues in the areas of System Design, Fuel Cycle, Infrastructure and Deployment, and Safety and Environmental Approval. Also included is the compilation of the individual task reports generated during Phase 1B.

6596 (NUREG/CP–0126-Vol.1, pp. 113-129) **A first look at LOCAs in the SBWR using RELAP5/MOD3.** Ghan, L.S. (Idaho National Engineering Lab., Idaho Falls (United States)); Shaw, R.A.; Kullberg, C.M. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Mar 1993. (CONF-921007–Vol.1: 20. water reactor safety information meeting, Bethesda, MD (United States), 21-23 Oct 1992). In *Proceedings of the US Nuclear Regulatory Commission twentieth water reactor safety information meeting: Volume 1, Plenary session, Advanced reactor research, Advanced passive LWRs, Advanced instrumentation and control hardware, Advanced control system technology, Human factors research, EPRI's nuclear safety research and development.* 524p. Source: OSTI; NTIS; INIS; GPO.

The General Electric Company (GE) is designing an advanced light-water reactor, the Simplified Boiling Water Reactor (SBWR), that utilizes passive safety concepts. The SBWR reactor coolant system will operate on natural circulation with decay heat removal and emergency core coolant injection being provided by passive, gravity-driven systems. The Idaho National Engineering Laboratory has developed an input model of the SBWR for the RELAP5/MOD3 thermal-hydraulic safety analysis code. Preliminary calculations have been performed to simulate three loss-of-coolant accidents: (1) a main steam line break, (2) spurious opening of one automatic depressurization valve, and (3) the rupture of the bottom drain line. Results from these three calculations were, in general, intuitively reasonable. The analyses revealed that the input model, which was created with preliminary design data, needs to be updated to reflect the current SBWR design. Nodalization of certain regions will also need to be improved. The results of the main steam line break calculation were compared to a similar TRACG calculation presented in GE's Standard Safety Analysis Report. Comparisons of the preliminary RELAP5/MOD3 results to TRACG results indicated good qualitative agreement. 5 refs., 12 figs., 1 tab.

6597 (NUREG/CP–0134, pp. 547-559) **Qualification issues associated with the use of advanced instrumentation and control systems hardware in nuclear power plants.** Korsah, K. (Oak Ridge National Lab., TN (United States)); Antonescu, C. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. DOE Contract AC05-84OR21400. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

The instrumentation and control (I&C) systems in advanced reactors will make extensive use of digital controls, microprocessors, multiplexing, and fiber-optic transmission. Elements of these advances in I&C have been implemented on some current operating plants. However, the widespread use of the above technologies, as well as the use of artificial intelligence with minimum reliance on

human operator control of reactors, highlights the need to develop standards for qualifying I&C used in the next generation of nuclear power plants. As a first step in this direction, the protection system I&C for present-day plants was compared to that proposed for advanced light water reactors (ALWRs). An evaluation template was developed by assembling a configuration of a safety channel instrument string for a generic ALWR, then comparing the impact of environmental stressors on that string to their effect on an equivalent instrument string from an existing light water reactor. The template was then used to address reliability issues for microprocessor-based protection systems. Standards (or lack thereof) for the qualification of microprocessor-based safety I&C systems were also identified. This approach addresses in part issues raised in Nuclear Regulatory Commission policy document SECY-91-292, which recognizes that advanced I&C systems for the nuclear industry are "being developed without consensus standards, as the technology available for design is ahead of the technology that is well understood through experience and supported by application standards."

6598 (PSI–117) **Source term analyses for the Muehleberg nuclear power plant.** Afonso-Raguin, M. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Attimger, R.; Guentay, S.; Hirschmann, H.; Hosemann, J. P.; Lieber, K.; Megaritis, G.; Nicolescu, T.; Stiller, P.; Varadi, G.; Wanner, R. Paul Scherrer Inst. (PSI), Villigen (Switzerland). Jan 1992. 500p. (In German). Order Number DE94610805. Source: OSTI; NTIS; INIS.

In the study presented here, the source terms for six accident scenarios at the Muehleberg nuclear power station were investigated; namely two low pressure incidents, a high pressure incident, a fire, an earthquake and a plane crash. figs., tabs., 44 refs.

6599 (SAND–93-1092C) **Uses of zero-one sampling in probabilistic risk assessment.** Camp, A.L. Sandia National Labs., Albuquerque, NM (United States). 1993. 5p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–31: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001599. Source: OSTI; NTIS; INIS; GPO Dep.

The recent NUREG-1150 studies and the LaSalle Probabilistic Risk Assessment (PRA) include the most in-depth uncertainty analyses ever performed for commercial nuclear reactors. As a result, the methods used in these studies are often emulated and referenced as being the definitive approach for performing such uncertainty analyses. While the methods are believed to be robust and to reasonably reflect the magnitude of the uncertainties, it is important for future users of these methods to understand some of the subtle points of the analysis. In particular, zero-one sampling (ZOS) was a technique employed extensively in these studies. The purpose of this paper is to clarify the actual use of zero-one sampling in NUREG-1150 and discuss more precisely those applications for which zero-one sampling is appropriate.

6600 (WAPD-T–2969) **Initial data testing of ENDF/B-VI for thermal reactor benchmark analysis.** Williams, M.L. (Louisiana State Univ., Baton Rouge, LA (United States). Nuclear Science Center); Kahler, A.C.; MacFarlane, R.E.; Milgram, M.; Wright, R.Q. Bettis Atomic Power Lab., West Mifflin, PA (United States). [1991]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-911107–85: 1991 winter meeting of the American Nuclear Society (ANS), San Francisco, CA (United States), 10-15 Nov 1991). Order Number DE94004448. Source: OSTI; NTIS; INIS; GPO Dep.

This paper summarizes some early data testing of ENDF/B-VI by members of the Cross Section Evaluation Working Group (CSEWG) Thermal Reactor Data Testing Subcommittee. Projections of ENDF/B-VI performance in thermal benchmark calculations are beginning to be available; and in some cases the calculations were performed with only a portion of the cross sections taken from version VI, the remainder taken from earlier data files. A factor delaying the thermal reactor data testing is that the final ^{235}U evaluation has not yet been officially released–only an earlier evaluation with a constant low-energy eta value (like in version V) is currently available. The official version VI ^{235}U evaluation (scheduled for release as Mod-1) gives a drooping eta variation at low energy; i.e., eta decreases with decreasing energy. This behavior was suggested by European studies to improve the calculation of temperature coefficients in LWRs.

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 6597, 6600, 6621, 6645, 6704, 6706, 6709, 6712, 6713, 6714, 6715, 6716, 6717, 6718, 6728, 6732, 6737, 6738, 6742, 6744, 6985, 6988, 7545

6601 (DOE/ER/12898–2) **The evaluation of the use of metal alloy fuels in pressurized water reactors: Final report.** Lancaster, D. Georgia Inst. of Tech., Atlanta, GA (United States). School of Mechanical Engineering. 26 Oct 1992. 309p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER12898. Order Number DE94003522. Source: OSTI; NTIS; INIS; GPO Dep.

The use of metal alloy fuels in a PWR was investigated. It was found that it would be feasible and competitive to design PWRs with metal alloy fuels but that there seemed to be no significant benefits. The new technology would carry with it added economic uncertainty and since no large benefits were found it was determined that metal alloy fuels are not recommended. Initially, a benefit was found for metal alloy fuels but when the oxide core was equally optimized the benefit faded. On review of the optimization of the current generation of "advanced reactors," it became clear that reactor design optimization has been under emphasized. Current "advanced reactors" are severely constrained. The AP-600 required the use of a fuel design from the 1970's. In order to find the best metal alloy fuel design, core optimization became a central effort. This work is ongoing.

6602 (KAERI/AR–375/93) **Design pressure and design program of shutdown cooling system to prevent the interfacing system LOCA for PWR.** Park, Sung Chan (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Oh, Jong Phil; Kim, Ho Young. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Apr 1993. 66p. Order Number DE94610814. Source: OSTI; NTIS (US Sales Only); INIS.

This is a technical state of the art report for the prevention methodology of the Interfacing System LOCA (ISLOCA) resulted from the rupture of the Shutdown Cooling System outside the containment which is designed at low pressure and directly connected to the Reactor Coolant System in Pressurized Water Reactor. The ISLOCA had occurred in the U.S.A. (three reported event, Vermont Yankee-12/12/75, Browns Ferry 1-8/14/84, and Pilgrim-9/29/83), and the U.S. NRC reviewed the event in early 1980s. The U.S. NRC's review results revealed that the probability of ISLOCA is considerably higher than expected. As a result, the U.S. NRC began to have a great concerns for the ISLOCA. The nuclear power plant suppliers in U.S.A. have also tried to improve the system to prevent the ISLOCA. While the U.S. NRC did not express any official position or issue the design requirements for the ISLOCA as of 1992, the nuclear power plant suppliers present the conceptual design features without detail design analysis. The ongoing project of Ulchin Nuclear Power Plant Units 3 and 4 (UCN 3/4) design in Korea requires prevention of the ISLOCA, however, there are some difficulties in implementing the design requirements in the aspects of system configuration and component manufacturing. This report summurized the current position of the U.S. NRC and the design concept of the Advanced Light Water Reactor. Based on these review, design features which can prevent the ISLOCA are presented for use in the UCN 3/4 or future plant design. (Author).

6603 (KAERI/TR–253/92) **Nuclear design report for kori nuclear power plant unit 4 cycle 7.** Baik, Joo Hyun (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Kang, Jung Min; Park, Sang Yoon; Song, Jae Woong. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Apr 1992. 124p. Order Number DE94610815. Source: OSTI; NTIS (US Sales Only); INIS.

This report presents nuclear design calculation for Cycle 7 of Kori Unit 4. Information is given on fuel loading, power density distributions, reactivity coefficients, control rod worths and operational limits. In addition, the report contains all necessary data for the

startup tests including predicted values for the comparison with the measured data. The reload consists of 64 KOFA's enriched by nominally 3.70 w/o U235. Among the KOFA's, 36 fuel assemblies contain gadolinia rods. The fuel assemblies in the core are arranged in a low leakage loading pattern. The cycle length of Cycle 7 amounts to 384 EFPD corresponding to a cycle burnup of 15420 MWD/MTU. (Author).

6604 (KAERI/TR–266/92) **Reload safety evaluation report for kori nuclear power plant unit 2 cycle 9.** Cho, Beom Jin (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Kim, Si Yong; Kim, Oh Hwan; Nam, Kee Il; Um, Gil Sup; Ban, Chang Hwan; Choi, Dong Uk; Yoon, Kyung Ho. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Apr 1992. 32p. Order Number DE94610816. Source: OSTI; NTIS (US Sales Only); INIS.

The Kori Nuclear Power Plant Unit 2 (Kori-2) is anticipated to be refuelled with 16x16 Korean Fuel Assemblies (KOFA), which are based on the KAERI design starting from Cycle 8. This report presents a reload safety evaluation for Kori-2, Cycle 9 and demonstrates that the reactor core being composed of various fuel assembly types as described below will not adversely affect the safety of the public and the plant. The evaluation of Kori-2, Cycle 9 was accomplished utilizing the methodology described in 'Reload Transition Safety Report for KORI 2' (Ref. /1-1/). The reload core for Kori-2, Cycle 9 is entirely comprised of 16x16 KOFA. In the Kori-2 licensing documentation to KEPCO the reference safety evaluation was provided for the operation of a reactor core fully loaded with KOFA as well as associated proposed changes to the Kori-2 Technical Specifications. The reload for Kori-2, Cycle 9 also introduces UO_2/Gd_2O_3 containing fuel rods. The use of fuel rods with Gd_2O_3 poisoning of the fuel has been approved as a part of the above mentioned licensing documentation. All of the accidents comprising the licensing bases which could potentially be affected by the fuel reload have been reviewed for the Cycle 9 core design described herein. (Author).

6605 (KAERI/TR–270/92) **Development of personal computer/workstation (PC/WS) versions of NLOOP code and establishment of the analysis procedure using the developed PC/WS versions.** Kim, Hee Cheol (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Um, Kil Sup; Yoon, Han Young. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). May 1992. 92p. (In Korean). Order Number DE94610817. Source: OSTI; NTIS (US Sales Only); INIS.

Developed are the personal Computer/Workstation (PC/WS) versions of NLOOP code which is used in the transient/accident analysis for Westinghouse plants and established are the analysis procedure using the developed PC/WS versions of NLOOP Code. MS Fortran and Demain/OS Fortran complier are used to install the PC Version and Workstation Version respectively. The 'on-line graphic' embodied by C language utilizing the basic graphic functions of PC and WS which displays the calculational results in the monitor is also developed. Finally, the analysis procedure is established by developing the auxiliary programs producing the basic data necessary to the documentation rapidly. (Author).

6606 (KAERI/TR–293/92) **Nuclear design report for kori nuclear power plant unit 2, cycle 9.** Oh, Se Kee (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Cho, Beom Jin; Kim, Si Yong; Lee, Chung Chan; Zee, Sung Kyun; Moon, Bok Ja. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jul 1992. 122p. Order Number DE94610818. Source: OSTI; NTIS (US Sales Only); INIS.

This report presents nuclear design calculations for Cycle 9 of Kori Unit 2. Information is given on fuel loading, power density distributions, reactivity coefficients, control rod worths and operational limits. In addition, the report contains all necessary data for the startup tests including predicted values for the comparison with the measured data. The reload consists of 56 KOFA's enriched by nominally 3.50 w/o U235. Among the KOFA's, 28 fuel assemblies contain gadolinia rods. The fuel assemblies in the core are arranged in a low leakage loading pattern. The cycle length of Cycle 9 amounts to 374 EFPD corresponding to a cycle burnup of 14730 MWD/MTU. (Author).

6607 (KAERI/TR–304/92) **A technical report on the operational data analysis for kori-2, cycle-7.** Baik, Joo Hyun (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Song, Jae Woong; Cho, Byung Oh; Lee, Sang Hoon. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Oct 1992. 97p. (In Korean). Order Number DE94610819. Source: OSTI; NTIS (US Sales Only); INIS.

The operational data analysis for Kori-2, Cycle-7 which Korean Fuel Assemblies (KOFA) have firstly loaded in PWR of Korea has been performed, in order to catch the operational behaviors and to make the design verification. Nuclear parameters related to the core reactivity and the power distribution have been compared between measured and predicted data, and they have been also satisfied with the design criteria and the safety limits. (Author).

6608 (KAERI/TR–316/92) **Reload safety evaluation report for Ulchin nuclear power plant unit 1 cycle 5.** Park, Chan Oh (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Kim, Yong Rae; Son, Sang Rin; Oh, Dong Seok; Kim, Hong Jin; Yoon, Kyung Ho; Yoon, Han Young; Choi, Han Rim; Choi, Dong Uk. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Dec 1992. 35p. Order Number DE94610820. Source: OSTI; NTIS (US Sales Only); INIS.

This report presents the reload safety evaluation for Ulchin 1, Cycle 5 and demonstrates that the reactor core being composed of various fuel assembly types applied in this evaluation will not adversely affect the safety of the public and the plant. All of the accidents comprising the licensing bases which could potentially be affected by the reload fuel assemblies have been reviewed for the Cycle 5 core and results are described in this report. (Author).

6609 (KAERI/TR–320/92) **ELESTRES.M11K program users'manual and description.** Suk, H. C. (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Hwang, W.; Kim, B. G.; Sim, K. S.; Heo, Y. H.; Byun, T. S.; Park, G. S. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Dec 1992. 265p. Order Number DE94610821. Source: OSTI; NTIS (US Sales Only); INIS.

ELESTRES.M11K is a computer program for simulating the behaviour of UO_2 fuel elements under normal operating conditions of a CANDU reactor. It computers the one-dimensional temperature distribution and thermal expansion of the fuel pellets, and computes two-dimensional pellet deformation using FEM. The amount of fission gas released and sheath strain/stress are also computed. This document is intended as a users' manual and description for ELESTRES.M11K program. (Author).

6610 (KAERI/TR–325/92) **Nuclear design report for Ulchin nuclear power plant unit 1 cycle 5.** Zee, Sung Kyun (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Kim, Yong Rae; Shon, Sang Rin; Lee, Chung Chan. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Dec 1992. 122p. Order Number DE94610822. Source: OSTI; NTIS (US Sales Only); INIS.

This report presents nuclear design calculation for Cycle 5 of Ulchin Unit 1. Information is given on fuel loading, power density distributions, reactivity coefficients, control rod worths and operational limints. In addition, the report contains all necessary data for the startup tests including predicted values for the comparison with the measured data. The reload consists of 48 KOFA's enriched by nominally 3.50 w/o U235. Among the KOFA's, 20 fuel assemblies contain gadolinia rods. The fuel assemblies in the core are arranged in a low leakage loading pattern. The cycle length of Cycle 5 amounts to 287 EFPD corresponding to a cycle burnup of 11510 MWD/MTU. (Author).

6611 (KAERI/TR–329/93) **Reload safety evaluation report for yonggwang nuclear power plant unit 2 cycle 7.** Zee, Sung Kyun (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Choi, Gyoo Hwan; Lee, Ki Bog; Park, Sang Yoon. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jan 1993. 32p. Order Number DE94610823. Source: OSTI; NTIS (US Sales Only); INIS.

This report presents the reload safety evaluation for YGN-2, Cycle 7 and demonstrates that the reactor core being entirely composed of KOFA as described below will not adversely affect the safety of the public and the plant. All of the accidents comprising

the licensing bases which would potentially be affected by the reload fuel assemblies have been reviewed for the Cycle 7 core design described herein. (Author).

6612 (KAERI/TR–331/93) **A technical report on the operational data analysis for Yonggwang-2 cycle-4.** Zee, Sung Kyun (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Lee, Ki Bog; Song, Jae Woong. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Feb 1993. 66p. (In Korean). Order Number DE94610824. Source: OSTI; NTIS (US Sales Only); INIS.

The reliability of reactor core design is verified by the comparison of measured data and predicted data, which will improve the safety and the economy in plant operation. This report contains the results of the operational data analysis for nuclear key parameters in Yonggwang-2 Cycle-4. The analyzed nuclear parameters are classified into two categories : reactivity parameters and power distribution parameters. It is verified that the predicted values for these parameters not only coincided well with the measured values but satisfied the safety limits. Through this work, it is turned out that some important points(boron biasing, etc.) may be provided in the nuclear design of the next cycle. (Author).

6613 (KAERI/TR–332/93) **Nuclear design report for Yonggwang nuclear power plant unit 2 cycle 7.** Zee, Sung Kyun (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Choi, Gyoo Hwan; Lee, Ki Bog; Park, Sang Yoon. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Feb 1993. 124p. Order Number DE94610825. Source: OSTI; NTIS (US Sales Only); INIS.

This report presents nuclear design calculations for Cycle 7 of Yonggwang Unit 2. Information is given on fuel loading, power density distributions, reactivity coefficients, control rod worths and operational limits. In addition, the report contains all necessary data for the startup tests including predicted values for the comparison with the measured data. The reload consists of 64 KOFA's enriched by nominally 3.70 w/o U235. Among the KOFA's, 40 fuel assemblies contain gadolinia rods. The fuel assemblies in the core are arranged in a low leakage loading pattern. The cycle length of Cycle 7 amounts to 367 EFPD corresponding to a cycle burnup of 14770 MWD/MTU. (Author).

6614 (KAERI/TR–336/92) **An analysis on the design of the permanent refueling water level indication system of UCN 3 and 4 plants.** Ahn, Jang Sun (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)). Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Mar 1993. 59p. (In Korean). Order Number DE94610826. Source: OSTI; NTIS (US Sales Only); INIS.

The purpose of this report is analyse the operating range of the permanent refueling water level indication system during mid-loop operation for UCN 3 and 4. This analysis shows that the operating range becomes 2.4 inches. Besides, if the instrument errors, flow dynamics errors are taken into account, the operating range of PRWLIS for UCN 3 and 4 is about 1 inch. Therefore, the mid-loop operation for UCN 3 and 4 has a potential operating problem because of little margin in operating range. (Author).

6615 (KAERI/TR–354/93) **Reload safety evaluation of boron dilution accident related to shutdown margin proportional to boron concentration.** Zee, Sung Kyun (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Lee, Ki Bog; Song, Jae Woong. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jun 1993. 51p. (In Korean). Order Number DE94610827. Source: OSTI; NTIS (US Sales Only); INIS.

This report investigates the efficient safety evaluation method and analysis procedure on Boron Dilution Accident(BDA) under the proportional shutdown margin to boron concentration. Also investigated are problems caused by applying this shutdown margin limit. Through this investigation, the safety of Kori-3 Cycle-8, Yonggwang-2 Cycle-7, Kori-4 Cycle-8 and Yonggwang-1 Cycle-8 with respect to BDA is verified. In order to satisfy the shutdown margin requirement in the Technical Specifications, it is shown that the High Flux Alarm at Shutdown Setting for Kori-4 Cycle-8 and Yonggwang-1 Cycle-8 at Mode 5 should be set at 2 or the Technical Specification should be revised. (Author).

6616 (NUREG–1427) **Regulatory analysis for the resolution of Generic Issue 143: Availability of chilled water system and room cooling.** Leung, V.T. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution. Dec 1993. 76p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This report presents the regulatory analysis for Generic Issue (GI-143), "Availability of Chilled Water System and Room Cooling." The heating, ventilating, and air conditioning (HVAC) systems and related auxiliaries are required to provide control of environmental conditions in areas in light water reactor (LWR) plants that contain safety-related equipment. In some plants, the HVAC and chilled water systems serve to maintain a suitable environment for both safety and non-safety-related areas. Although some plants have an independent chilled water system for the safety-related areas, the heat removal capability often depends on the operability of other supporting systems such as the service water system or the component cooling water system. The operability of safety-related components depends upon operation of the HVAC and chilled water systems to remove heat from areas containing the equipment. If cooling to dissipate the heat generated is unavailable, the ability of the safety-related equipment to operate as intended cannot be assured. Typical components or areas in the nuclear power plant that could be affected by the failure of cooling from HVAC or chilled water systems include the (1) emergency switchgear and battery rooms, (2) emergency diesel generator room, (3) pump rooms for residual heat removal, reactor core isolation cooling, high-pressure core spray, and low-pressure core spray, and (4) control room. The unavailability of such safety-related equipment or areas could cause the core damage frequency (CDF) to increase significantly.

6617 (NUREG/CP–0134, pp. 405-420) **Reactor safety instrumentation of Paks NPP (experience and perspective).** Elo, S. (Hungarian Atomic Energy Commission, Budapest (Hungary)); Hamar, K. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

The majority of the existing control and protection systems in nuclear power plants use old analog technology and design philosophy. Maintenance and the procurement of spare parts is becoming increasingly difficult. In general there is an age degradation concern. Aging degradation in nuclear power plants must be effectively managed to avoid a loss of vital safety function, shutdown of the station, a reduced power generation, or any failure leading to expensive repair. Even with the best efforts in developing reliable and long life instrumentation and control systems for nuclear power plants it is expected that these systems for most plants will require replacements during the life of the plants. The instrumentation and control system of the nuclear power plants designed during the 70's and constructed in the 80's went out-of-date since nuclear safety is not a static concept and the digital computer technology has undergone rapid improvements during the 70's and 80's. Simultaneously the operation and the maintenance of the I&C system of those plants described above becomes more and more difficult and expensive. In this context the pure quality of the former Soviet designed process instrumentation system increases the needs of upgrading this system. The author reviews the main design characteristics of the reactor safety instrumentation of the Paks NPP. Further he attempts to convey the perspective on upgrading the reactor safety instrumentation as seen by the HAEC and its Nuclear Safety Inspectorate.

6618 (NUREG/CP–0134, pp. 463-477) **Instrumentation and control system upgrade plan for operating PWR plants in Japan.** Ishii, Hirofumi (Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States);

Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability*. 577p. Source: OSTI; NTIS; INIS; GPO.

Digital technology has been applied to all non-safety grade instrumentation and control (I&C) systems in the latest Japanese PWR plants, and has achieved more reliable and operable systems, easier maintenance and cable reductions. In the next stage APWR plants, the digital technology will be also applied to all the I&C systems including safety grade systems. Parallel to the above efforts, many backfitting programs in which the digital technology is applied to operating plants are under way to improve reliability and operability. The backfitting programs for operating plants are proceeded in two phases, synthesizing various utility's needs to improve plant availability and operability, improvement of digital technology, and complexity of the practicable replacement procedures. Phase 1 is a partial application of digital technology, while Phase 2 is a complete application of digital technology. Phase 1 has been implemented in a number of operation plants, while Phase 2 studies are in the design stage, but have not been implemented at this point. This paper presents examples of the partial application of digital technology to operating plants, and the contents of basic design for the complete application of digital technology.

6619 (NUREG/CP–0134, pp. 479-488) **Modernisation of the Borssele NPP reactor protection system.** Plas, Y. van der (Ministry of Social Affairs and Employment, The Hague (Netherlands)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability*. 577p. Source: OSTI; NTIS; INIS; GPO.

For several years the obligation to evaluate the safety level of nuclear power plants in The Netherlands against the state of the art has been required in the licenses of such plants. This was leading to backfitting programs for both nuclear power plants in The Netherlands. These programmes are in an engineering phase at present. One of the plants to be retrofitted is the Borssele NPP. This is a 450 MWe PWR, in operation since 1973. Design and construction is from Siemens/KWU. Its concept is from an earlier date than for instance the KWU-Konvoi design and thus shows more ramification and less separation in process, electrical and instrumental redundancies than more recent plant types. To combat dependencies in failure modes an additional bunkerized civil structure, Building 33, had been already erected in 1985. This building meets redefined requirements for flood, gas cloud explosion, and external fire. It provides space for the functionally and physically separated secondary loop. Independency has been acquired by its own power supply. These systems provide a certain back up for the primary volume control, the core injection system, and the auxiliary feed water supply in case of an external event. The present backfitting program is also utilizing the design considerations of these systems.

6620 (NUREG/CR–5897) **Auxiliary feedwater system risk-based inspection guide for the South Texas Project nuclear power plant.** Bumgardner, J.D. (Pacific Northwest Lab., Richland, WA (United States)); Nickolaus, J.R.; Moffitt, N.E.; Gore, B.F.; Vo, T.V. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Safety and Analysis; Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 32p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC06-76RL01830. (PNL–8104). Source: OSTI; NTIS; INIS; GPO.

In a study sponsored by the US Nuclear Regulatory Commission (NRC), Pacific Northwest Laboratory has developed and applied a methodology for deriving plant-specific risk-based inspection guidance for the auxiliary feedwater (AFW) system at pressurized water reactors that have not undergone probabilistic risk assessment (PRA). This methodology uses existing PRA results and plant operating experience information. Existing PRA-based inspection guidance information recently developed for the NRC for various plants was used to identify generic component failure modes. This information was then combined with plant-specific and industry-wide component information and failure data to identify failure modes and failure mechanisms for the AFW system at the selected plants. South Texas Project was selected as a plant for study. The product of this effort is a prioritized listing of AFW failures which have occurred at the plant and at other PWRs. This listing is intended for use by the NRC inspectors in preparation of inspection plans addressing AFW risk important components at the South Texas Project plant.

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 6712

6621 (NUREG/CP–0134, pp. 531-546) **Recent activities within Nuclear Electric related to the qualification of digital systems and the extension of maintenance intervals.** Holt, G.P. (Nuclear Electric plc, Barnwood (United Kingdom)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability*. 577p. Source: OSTI; NTIS; INIS; GPO.

Nuclear Electric is pursuing a program of modernization and enhancement of existing control and safety (C&I) systems to improve power plant availability and increase power output. This paper describes recent experience in qualifying digital systems for safety applications. Also, described is the work currently in hand to reduce the frequency of maintenance periods for safety C&I equipment. The qualification of digital systems is shown to be a more rigorous and much more extensive (and thus costly) exercise than the qualification of conventional equipment. This is illustrated by brief references to two software-based safety systems, the Single Channel Trip System at the Dungeness "B"AGR and the Primary Protection System for the new PWR at Sizewell "B". The emphasis of the paper is on the use of Application Specific Integrated Circuits (ASICs) in safety systems, to reduce, or eliminate dependence on software for the fulfillment of requirements which need implementations that are complex or of a high functional density. Recent experience in the development of a prototype safety system based on ASICs, The Gaseous Activity Monitor and Trip Equipment (GAM), is used to illustrate their possible benefits and potential problems. When using complex integrated circuits like microprocessors or ASICs in digital systems a difficulty arises in analyzing the failure modes of the system. Efforts to overcome this difficulty led to the development of a method for performing failure analyses based on functional blocks. The techniques and benefits of such an approach are outlined. Finally, efforts to reduce maintenance costs, yet at the same time enhance safety, are leading towards an extension of maintenance intervals, for some safety equipment, from 3 months to 4 months and also towards lengthening the period between AGR outages from 2 years to 3 years.

6622 (ORNL/FTR–4675) **Fission product behavior in gas-cooled reactors and fuel performance: Foreign trip report, June 19–27, 1993.** Myers, B.F. Oak Ridge National Lab., TN (United States). 12 Jul 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400.

Order Number DE93017911. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report discusses travel to a meeting of the members of the International Atomic Energy Agency (IAEA), Coordinated Research Program (CRP), in Vienna, Austria, where an agreement was reached to collate, review, and evaluate data and models in the selected categories of fuel performance, fission product behavior, and advanced fuels. The data and models will be incorporated in an expanded version of the current status report on fuel performance and fission product transport. The report will provide the basis for verification and validation efforts on models and codes in the selected categories. At the Forschungszentrum Juelich (KFA), a proposal for cooperative work was favorably received, and the postirradiation examination of capsules 1, 2, and 3 of the HFR-B1 was reviewed and discussed.

6623 (SAND–93-8245) **The effect of production temperature on the retention of tritium in vapor deposited beta silicon carbide.** Causey, R.A. (Sandia National Labs., Livermore, CA (United States)); Wampler, W.R.; Kaae, J.L. Sandia National Labs., Livermore, CA (United States). Oct 1993. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DR00789. Order Number DE94004275. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This is the final report in the prematurely terminated research program on the behavior of tritium in the NPR-MHTGR tritium target materials. This report addresses effect of production temperature of the silicon carbide layer on tritium permeation characteristics of the silicon carbide. Equilibrium tritium retention measurements performed using samples vapor deposited at 1400 and 1700C were compared to earlier results for samples deposited at 1550C. The tritium retention characteristics of the samples produced at 1400C were very similar to the earlier 1550C results. Results for tritium retained in the 1700C produced material was lower by approximately a factor of 3. The approach to equilibrium was determined for the different materials by outgassing samples that had been exposed to tritium gas at 1200C for different times. No significant differences in the time required to reach equilibrium were seen for the silicon carbides deposited at the different temperatures. Extensive research performed at General Atomics on the microstructure of the different materials was used to help explain the behavior differences.

2104 Power Reactors, Nonbreeding, Otherwise Moderated Or Unmoderated

6624 (KAERI/TR–255/92) **KAFEPA-II program users' manual and description.** Suk, H. C. (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Hwang, W.; Kim, B. G.; Sim, K. S.; Heo, Y. H.; Byun, T. S.; Park, G. S. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Apr 1992. 207p. Order Number DE94610850. Source: OSTI; NTIS (US Sales Only); INIS.

KAFEPA-II is a computer program for simulating the behaviour of UO_2 fuel elements under normal operating conditions of a CANDU reactor. It computes the one-dimensional temperature distribution and thermal expansion of the fuel pellets. The amount of gas released during irradiation of the fuel is also computed. Thermal expansion and gas pressure inside the fuel element are then used to compute the strains and stresses in the sheath. This document is intended as a user's manual and description for KAFEPA-II. (Author).

2105 Power Reactors, Breeding

Refer also to citation(s) 6151, 6710, 6711

6625 (DOE/FTR–93018611) **Travel to the Windscale and Dounreay sites in the United Kingdom to discuss the details of SNR-300 fuel assembly modification: Foreign trip report, July 12–19, 1991.** Chastain, S.A.; Trenchard, R.G.; Dittmer, J.O.; Smith, D.W. Westinghouse Hanford Co., Richland, WA (United States). [1991]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE93018611. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Modification of SNR-300 fuel assemblies for the first group of nine test assemblies will be performed at Windscale. Facilities which were proposed for assembly modification work were toured. The details of design, quality inspection and record keeping were discussed in detail and the TDD-1B (Fabrication Specification) was reviewed on a page by page basis. Shipment of the modified assemblies to the United States for irradiation in FFTF was also discussed. Shipping was recognized as a critical path item and to show good faith, the UK cask licensing group agreed to start work on cask license upgrades immediately. However, work on the cask license upgrade will only continue for two weeks without funding. Fabrication of the larger number of 217 pin assemblies which will be used as FFTF driver fuel assemblies will be performed at the Dounreay site. The proposed facility is a new building where the storage facility for all SNR-300 assemblies is co-located. The team discussions reaffirmed that the UK are anxious to assist in the modification of fuel assemblies and are willing to modify their fabrication techniques and equipment to meet the specifications required to convert SNR-300 assemblies for irradiation in FFTF.

6626 (KFK–5082) **LMFBR source term experiments with rupture disk discharge under sodium.** Minges, J.; Schuetz, W. Kernforschungszentrum Karlsruhe GmbH (Germany). Lab. fuer Aerosolphysik und Filtertechnik (LAF); Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Nukleare Sicherheitsforschung. May 1993. 117p. (In German). Order Number DE94734066. Source: OSTI; NTIS (US Sales Only); INIS.

In the frame of the KfK research program FAUST, contributions are given to the assessment of the instantaneous source term in case of an LMFBR loss-of-flow accident with expanding fuel or sodium vapour. The main goal of the program is to achieve information, mainly by experiments, on the retention capability of the primary sodium pool for fuel and fission products. For that purpose, it is necessary to investigate the interaction of bubble and aerosol behaviour after a pressure discharge, and the subsequent aerosol transport. After a series of water tests (FAUST-1), rupture disk discharge tests under 500 C sodium up to 3.81 MPa were performed during the phase FAUST-2 with the two test facilities 2A (about 2 liters of sodium) and 2B (about 200 liters of sodium). The discharge tests were performed with pressurized argon gas and admixtures of the simulation materials Cs, CsI, NaI, I_2, SrO, and UO_2. Cs was a liquid, I_2 vapour, and all other substances solid particles. Besides UO_2, non-radioactive material was used (natural isotopes). The retention capability of liquid sodium is expressed by retention factors RF. In general, RF is defined as the mass ratio of discharged amount, and the amount which is detected in the cover gas for the relevant species. From sampling immediately after the discharge, the instantaneous retention factors are deduced. From retarded sampling, the 'delayed factors' follow. High pressure discharge creates two important removal mechanisms, namely 'impaction by inertia relative to the bubble oscillations' and 'wash-out by sedimentation of entrained sodium droplets'. On the other hand, the retention of particles enclosed in a buoyantly rising bubble is significantly smaller. (orig.)

6627 (ORNL/TM–12391) **A nonlinear dynamic model of a once-through, helical-coil steam generator.** Abdalla, M.A. (Oak Ridge Inst. for Science and Education, TN (United States)). Oak Ridge National Lab., TN (United States). Jul 1993. 61p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94003811. Source: OSTI; NTIS; INIS; GPO Dep.

A dynamic model of a once-through, helical-coil steam generator is presented. The model simulates the advanced liquid metal reactor superheated cycle steam generator with a four-region, moving-boundary, drift-flux model. The model is described by a set of nonlinear differential equations derived from the fundamental equations of conversation of mass, energy, and momentum. Sample results of steady-state and transient calculations are presented.

6628 (WHC-MR–0451) **Characterization of the sodium void reactivity effect for advanced liquid metal reactor fuels.** Kessler, S.F. Westinghouse Hanford Co., Richland, WA (United States). Dec 1993. 250p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94005487. Source: OSTI; NTIS; INIS; GPO Dep.

Thesis submitted to University of Washington.

This report discusses the problems of a large positive sodium void reactivity effect in liquid metal reactors which have received increased attention following the accident at Chernobyl, a light water reactor with a positive coolant void coefficient. While the probability of voiding sodium is small, a large positive sodium void reactivity effect is, in many minds, unacceptable. Analyses were performed on models of an advanced liquid metal reactors to determine the effects fuel type have on the sodium void reactivity effect. Three fuel types were considered; metal, oxide, and nitride. Calculations were performed using three-dimensional, multigroup diffusion theory. Two programs were developed to aid the analyses. One calculated the capture-to-fission ratio and the other calculated reaction rates of selected materials. A one-group equation was derived to determine a theoretical basis for the sodium void reactivity effect. An option was presented for a shortened core having a near-zero sodium-void worth. The effect on the sodium void reactivity effect of using actinides as fuel is also considered.

2106 Power Reactors, Mobile, Propulsion, Package, and Transportable

Refer also to citation(s) 6740, 7039, 7184

6629 (DOE/NE/32170–23) **Preliminary reentry safety assessment of the General Purpose Heat Source module for the Cassini mission: Aerospace Nuclear Safety Program.** Conn, D.W.; Brenza, P.T. Johns Hopkins Univ., Laurel, MD (United States). Applied Physics Lab. Apr 1993. 57p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI01-93NE32170. (ANSP-M–23). Order Number DE94001646. Source: OSTI; NTIS; GPO Dep.

As asked by the U. S. Department of Energy/Office of Special Applications, and in support of the Environmental Impact Statement for the Cassini mission, The Johns Hopkins University/Applied Physics Laboratory (JHU/APL) has conducted preliminary one-dimensional ablation and thermal analyses of the General Purpose Heat Source (GPHS). The predicted earth entry conditions provided by the Jet Propulsion Laboratory (JPL) for a Cassini Venus-Venus-Earth-Jupiter Gravity Assist (VVEJGA) trajectory were used as initial conditions. The results of this study which constitute the initial reentry analysis assessment leading to the Cassini Updated Safety, Analysis Report (USAR) are discussed in this document.

6630 (DOE/SF/19441–T5) **SPACE-R thermionic space nuclear power system: Design and technology demonstration: Task 1.5.6, Moderator containment laboratory experiment test plant (CDRL No. 5).** Space Power, Inc., San Jose, CA (United States). Oct 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-92SF19441. Order Number DE94001890. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The preferred moderator being considered for SPACE-R is yttrium hydride encased in beryllium tubes. The baseline beryllium performs a dual function as it acts as a moderator and provides containment for hydrogen. The permeation rate of hydrogen from the hydride through the beryllium shell at the operating temperature is an important factor for the functionality and reliability of the Be-YHx moderator. Hydrogen containment capability of beryllium is comparable to enamel which was used in SNAP and Topaz II reactors. However, limited experimental data base exists for the hydrogen permeation through fabricated beryllium enclosures at high temperature. Permeation of hydrogen in beryllium is strongly affected by surface conditions, thickness of surface oxide, surface and bulk traps, impurity content and microstructure. The objective of this experiment is to determine the permeation rate of hydrogen from yttrium hydride and zirconium hydride through beryllium in the temperature range of 773 K–973 K. In addition, Topaz II type zirconium hydride specimens with and without the proprietary oxide coating canned in stainless steel will be tested to measure the hydrogen permeation rate. The TSET SS-canned ZrHx samples currently at Phillips Laboratory will be used for the latter test with Phillips Laboratory participation at the SPI hydrogen leak test stand. A key technology demonstration of the effectiveness of transferred arc plasma spraying of a 1 mil Molybdenum coating on the Be cladding will be performed. The effectiveness of the Molybdenum coating in preventing any interaction of Be with Stainless Steel in NaK will be assessed and demonstrated.

6631 (DOE/SF/19441–T6) **SPACE-R thermionic space nuclear power system design and technology demonstration: Test plans for INERTEK experimental tasks: CDRL No. 5 and No. 9.** Space Power, Inc., San Jose, CA (United States). Oct 1993. 66p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-92SF19441. Order Number DE94002017. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This document provides the INERTEK Experimental Test Plans for the SPACE-R Thermionic Space Nuclear Power System. These plans are: Monocrystal Alloy 1-Dimensional Creep Test; Monocrystal Alloy 2- Dimensional Creep Test; Fuel Specimen In-Pile Test; Moderator Irradiation Test; Demonstration of High Performance Single Cell TFE without Fuel; and Long Cell Fuel Element Irradiation Demonstration.

6632 (LA-UR–93-3595) **Technical accomplishments of the Thermionic Fuel Element Verification Program.** Houts, M.G. (Los Alamos National Lab., NM (United States)); Begg, L.L.; Wharton, W.R. Jr.; Lawrence, L.A. Los Alamos National Lab., NM (United States). [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940101–14: 11. symposium on space nuclear power systems, Albuquerque, NM (United States), 9-13 Jan 1994). Order Number DE94002635. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report discusses Thermionic Fuel Element Verification Program (TFEVP) was created to demonstrate the technological readiness of a Thermionic Fuel Element (TFE) suitable for use as the basic element in a thermionic reactor having an electric power output in the 0.5- to 5-MWe range and a full-power life of seven years. The TFEVP has made significant progress in developing components capable of withstanding the required neutron fluence (4×10^{22} n/cm^2, E > 0.1 MeV) and the required burnup (5.3%). Technology developed under the TFEVP also supports the 5- to 40-kWe thermionic systems currently of interest to the Strategic Defense Initiative Organization and the United States Air Force. The fast-neutron flux in certain 5- to 40-kWe systems is nearly an order of magnitude less than that in 0.5- to 5-MWe systems. Component technology that has been developed for 0.5- to 5-MWe systems will thus be suitable for use in long-life, high-performance, 5- to 40-kWe systems. Components that are being developed by the TFEVP include insulator seals, sheath insulators, fueled emitters, cesium reservoirs, and interconnective TFE components. In addition, the TFEVP has created a preliminary 2-MWe-system design and has evaluated converter performance under various conditions. Six integrated TFEs have also been tested. The TFEVP has encountered and surmounted problems in developing and testing long-life TFEs. The emphasis of the US thermionic reactor development effort has shifted to the development of a 40-kWe thermionic space nuclear power supply. The TFEVP will be closed out by the end of fiscal year 1994, with the closeout optimized for yielding the maximum overall program benefit-to-cost ratio. Information gained during the closeout will be very useful to the development of 40-kWe and other thermionic systems.

6633 (LA-UR–93-3651) **Modelling the mass migration phenomena in partially frozen heat pipes.** Keddy, M.D. (Los Alamos National Lab., NM (United States)); Merrigan, M.A.; Critchley, E. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940101–16: 11. symposium on space nuclear power systems, Albuquerque, NM (United States), 9-13 Jan 1994). Order Number DE94002716. Source: OSTI; NTIS; GPO Dep.

Liquid metal heat pipes operated at power throughputs well below their design point and with sink temperatures below the freezing temperature of the working fluid may fail as a result of the working fluid migrating to a cold region within the pipe, freezing there, and not returning to the evaporator section. Eventually, sufficient working fluid inventory may be lost to the cold region to cause a local dry-out condition in the evaporator. A joint experimental and analytical effort by the Air Force Phillips Laboratory and Los Alamos National Laboratory is underway to investigate this

phenomena. This paper presents an analytical model developed to describes this phenomena. The model provides for analytic determination of heat pipe temperature profiles, freeze-front locations and mass migration rates.

6634 (LA-UR–93-3726) **Design and performance of the UO_2 fuel for the Topaz-II reactor.** Hoth, C.W. (Los Alamos National Lab., NM (United States)); Degaltsev, Y.; Gontar, A.; Rakitskaya, E. Los Alamos National Lab., NM (United States). [1993]. 8p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940101–15: 11. symposium on space nuclear power systems, Albuquerque, NM (United States), 9-13 Jan 1994). Order Number DE94002691. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The Russian Topaz-II space reactor system is being modified for use for the United States - Nuclear Electric Propulsion Space Test Project (NEPSTP). The nuclear reactor fuel consists of annular UO_2 fuel pellets with 17 mm diameter and 9 mm height. The fuel is fabricated to high purity and high density (96% theoretical density). The reactor core contains 37 single-cell thermionic fuel elements (TFEs), each with approximately 40 fuel pellets. The fuel pellets are contained within an emitter tube of single crystal Mo-3%Nb with a tungsten coating on the outer surface to enhance thermionic emission. The fuel has evolved through an ongoing development program to provide low swelling and very high mechanical strength. Extensive irradiation testing, chemical compatibility testing, and vibration testing were conducted in Russia to verify the performance and lifetime capabilities of the fuel and TFE. This paper summarizes the fuel design, fuel development, and performance testing of the UO_2 fuel for the TOPAZ-II reactor.

6635 (SAND–93-2296C) **An assessment of testing requirement impacts on nuclear thermal propulsion ground test facility design.** Shipers, L.R.; Ottinger, C.A.; Sanchez, L.C. Sandia National Labs., Albuquerque, NM (United States). 25 Oct 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940101–18: 11. symposium on space nuclear power systems, Albuquerque, NM (United States), 9-13 Jan 1994). Order Number DE94002933. Source: OSTI; NTIS; INIS; GPO Dep.

Programs to develop solid core nuclear thermal propulsion (NTP) systems have been under way at the Department of Defense (DoD), the National Aeronautics and Space Administration (NASA), and the Department of Energy (DOE). These programs have recognized the need for a new ground test facility to support development of NTP systems. However, the different military and civilian applications have led to different ground test facility requirements. The Department of Energy (DOE) in its role as landlord and operator of the proposed research reactor test facilities has initiated an effort to explore opportunities for a common ground test facility to meet both DoD and NASA needs. The baseline design and operating limits of the proposed DoD NTP ground test facility are described. The NASA ground test facility requirements are reviewed and their potential impact on the DoD facility baseline is discussed.

6636 (SAND–93-2696C) **Design and construction of the TOPAZ II reactor system real-time dynamic simulator.** Kwok, K.S. Sandia National Labs., Albuquerque, NM (United States). 12 Nov 1993. 8p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940101–21: 11. symposium on space nuclear power systems, Albuquerque, NM (United States), 9-13 Jan 1994). Order Number DE94003789. Source: OSTI; NTIS (US Sales Only); GPO Dep.

A dynamic simulator of the TOPAZ II reactor system has been developed for the Nuclear Electric Propulsion Space Test Program. The simulator is a self-contained IBM-PC compatible based system that executes at a speed faster than real-time. The CPU is an 80486 DX2 processor operating at 66 MHz. The data acquisition system also employs an 80486 processor at 24 MHz on board. The data acquisition system is capable of providing 128 channels of analog-to-digital inputs at 1.3 MHz simultaneously, 64 channels of digital inputs at 1.6 MHz on a single channel, 64 channels of digital outputs at 1.6 MHz on a single channel, and 66 digital-to-analog channels at 1.6 MHz on a single channel. The simulator software operates in the Windows environment. The overall execution time of the simulator for each time step is 15 ms when no data is written to the disk, and 18 ms when nine double precision data points are written to the disk once in every time step. The simulator combines first-principle modeling and empirical correlations in its algorithm to attain the modeling accuracy and computational through-put that are required for real-time execution. It has been found to provide realistic real-time dynamic response of the TOPAZ II reactor system.

2107 Regulation and Licensing

Refer also to citation(s) 6314, 6621, 6678

6637 (DOE/OR/00033–T572) **The use of probabilistic risk assessment to satisfy the Nuclear Regulatory Commission's maintenance rule.** Dubord, R.M. (Massachusetts Inst. of Tech., Cambridge, MA (United States). Dept. of Nuclear Engineering). Oak Ridge Inst. for Science and Education, TN (United States); Massachusetts Inst. of Tech., Cambridge, MA (United States). Dept. of Nuclear Engineering. May 1993. 97p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE94001415. Source: OSTI; NTIS; INIS; GPO Dep.

Maintenance and inspection at nuclear power plants consumes a large portion of a utility's resources, making resource allocation for such procedures vital. The NRC Maintenance Rule, due to be implemented in July of 1996, requires utilities to select systems, structures, and components (SSCS) important to safety and to develop a monitoring program to ensure that these SSCs are capable of fulfilling their intended functions. In light of these concerns, two ratios were developed to compare the risk significance of individual components with the amount of plant staff time, or burden, associated with inspecting the component. These risk/burden ratios point out existing disparities between current inspection practices and safety concerns. These ratios can be used to develop new inspection schedules constituting a more equitable risk to burden distribution.

6638 (INIS-mf–13736) **Manual of quality assurance programme auditing.** Bezpecnost Jadernych Zarizeni, no.3. Statni Urad pro Jadernou Bezpecnost, Prague (Czech Republic). 1993. 93p. Translation of Manual of Quality Assurance Programme Auditing, STI/DOC/10/237, International Atomic Energy Agency, Vienna, 1984. (In Czech). Order Number DE94611050. Source: OSTI; NTIS (US Sales Only); INIS.

The objective of this Manual is to provide guidance and illustrative examples of the methodology and techniques of internal and external audits that are consistent with the requirements and recommendations of the Code and the Safety Guide. The methodology and techniques are based on the practices of Member States having considerable experience in auditing QA programmes. This Manual is directed primarily towards QA programme auditors and managers and presents methods and techniques considered appropriate for the preparation and performance of audits and the evaluation of results. Its scope includes the techniques and methods used to carry out QA programme audits variously described as 'System', 'Product' and 'Process' audits. The techniques and methods described here may be used as one approach to the evaluation of suppliers' QA capabilities as defined in 50-SG-QA10. Although the Manual is primarily directed towards purchasers and suppliers, it is also relevant to regulatory organizations, such as government offices responsible for quality assurance, which carry out external audits independent of purchasers and suppliers. In such cases similar methods, procedures and techniques may be used.

6639 (NUREG–0540-Vol.15-No.10) **Title list of documents made publicly available, October 1–31, 1993: Volume 15, No. 10.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Dec 1993. 270p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This document is a monthly publication containing descriptions of information received and generated by the US Nuclear Regulatory Commission (NRC). This information docketed material associated

with civilian nuclear power plants and other uses of radioactive materials, and nondocketed material received and generated by NRC pertinent to its role as a regulatory agency. The following indexes are included: Personal Author, Corporate Source, Report Number, and Cross Reference of Enclosures to Principal Documents.

6640 (NUREG/CP–0134, pp. 43-68) **License renewal.** Newberry, S. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This article gives an overview of the process of license renewal for nuclear power plants. It explains what is meant by license renewal, the significance of license renewal, and goes over key elements involved in the process of license renewal. Those key elements are NRC requirements embodied in 10 CFR Part 54 (Reactor Safety) and 10 CFR Part 51 (Environmental Issues). In addition Industry Reports must be developed and reviewed. License renewal is essentially the process of applying for a 20 year extension to the original 40 year operating license granted for the plant. This is a very long term process, which involves a lot of preparation, and compliance with regulatory rules and guidelines. In general it is a process which is expected to begin when plants reach an operating lifetime of 20 years. It has provisions for allowing the public to become involved in the review process.

6641 (NUREG/CP–0134, pp. 363-390) **Regulatory perspective on digital instrumentation and control systems for future advanced nuclear power plants.** Chiramal, M. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper deals with the question of using digital technology in instrumentation and control systems for modern nuclear power reactors. The general opinion in the industry and among NRC staff is that such technology provides the opportunity for enhanced safety and reliable reactor operations. The major concern is the safe application of this technology so as to avoid common mode or common cause failures in systems. There are great differences between digital and analog system components. SECY-91-292 identifies some general regulatory concerns with regard to digital systems. There is clearly a lack of adequate regulatory direction on the application of digital equipment at this time, but the issue is being addressed by the industry, outside experts, and NRC staff. NRC staff presents a position on the issue of defense-in-depth and diversity with regard to insuring plant safety. Independent manual controls and readouts must be available to allow safe shutdown and monitoring of the plant in the event of safety system failures.

6642 (SNL/NM–699795-7) **Early Site Permit Demonstration Program: Recommendations for communication activities and public participation in the Early Site Permit Demonstration Program.** Sandia National Labs., Albuquerque, NM (United States); Smith and Harroff, Inc., Alexandria, VA (United States); Southern Electric International, Inc., Atlanta, GA (United States); Commonwealth Research Corp., Chicago, IL (United States); Public Service Electric and Gas Co., Newark, NJ (United States). 27 Jan 1993. 125p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94002874. Source: OSTI; NTIS; INIS; GPO Dep.

On October 24, 1992, President Bush signed into law the National Energy Policy Act of 1992. The bill is a sweeping, comprehensive overhaul of the Nation's energy laws, the first in more than a decade. Among other provisions, the National Energy Policy Act reforms the licensing process for new nuclear power plants by adopting a new approach developed by the US Nuclear Regulatory Commission (NRC) in 1989, and upheld in court in 1992. The NRC 10 CFR Part 52 rule is a three-step process that guarantees public participation at each step. The steps are: early site permit approval; standard design certifications; and, combined construction/operating licenses for nuclear power reactors. Licensing reform increases an organization's ability to respond to future baseload electricity generation needs with less financial risk for ratepayers and the organization. Costly delays can be avoided because design, safety and siting issues will be resolved before a company starts to build a plant. Specifically, early site permit approval allows for site suitability and acceptability issues to be addressed prior to an organization's commitment to build a plant. Responsibility for site-specific activities, including communications and public participation, rests with those organizations selected to try out early site approval. This plan has been prepared to assist those companies (referred to as sponsoring organizations) in planning their communications and public involvement programs. It provides research findings, information and recommendations to be used by organizations as a resource and starting point in developing their own plans.

2108 Economics

Refer also to citation(s) 6595

6643 (DOE/EIA–0436(93)) **World nuclear capacity and fuel cycle requirements, November 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. 30 Nov 1993. 162p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003847. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

This analysis report presents the current status and projections of nuclear capacity, generation, and fuel cycle requirements for all countries in the world using nuclear power to generate electricity for commercial use. Long-term projections of US nuclear capacity, generation, fuel cycle requirements, and spent fuel discharges for three different scenarios through 2030 are provided in support of the Department of Energy's activities pertaining to the Nuclear Waste Policy Act of 1982 (as amended in 1987). The projections of uranium requirements also support the Energy Information Administration's annual report, Domestic Uranium Mining and Milling Industry: Viability Assessment.

6644 (INIS-mf–13745) **Summary of a reference book on financing arrangements for nuclear power projects in developing countries.** International Atomic Energy Agency, Vienna (Austria). May 1993. 21p. Order Number DE94610957. Source: OSTI; NTIS (US Sales Only); INIS.

Also published in French, Russian and Spanish.

The IAEA has recently published a reference book entitled Financing Arrangements for Nuclear Power Projects in Developing Countries (Technical Reports Series No. 353). The book reviews comprehensively the main features and problems concerning the financing of such projects in developing countries and presents innovative approaches for power generation financing. It also discusses the special conditions and requirements of nuclear power projects and the complexities of their financing, focusing on the practical issues to be dealt with to achieve successful financing, as well as the constraints encountered by most developing countries. This booklet summarizes the important features of the financing arrangements discussed in the reference book and was prepared with the aim of widely disseminating the results.

22 NUCLEAR REACTOR TECHNOLOGY

6645 (KAERI/TR–358/93) **Reload safety evaluation report for kori nuclear power plant unit 4, cycle 8.** Park, Chan Oh (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Jung, Yil Sup; Kim, Si Yong; Kim, Ki Hang; Kwon, Hyuk Sung; Oh, Dong Seok; Kim, Du Ill; Ban, Chang Hwan; Choi, Dong Uk. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jun 1993. 35p. Order Number DE94610771. Source: OSTI; NTIS (US Sales Only); INIS.

This report presents the reload safety evaluation for Kori-4, Cycle 8 and demonstrate that the reactor core being entirely composed of KOFA as described in the report will not adversely affect the safety of the public and the plant. All of the accidents comprising the licening bases which could potentially be affected by the fuel reload have been reviewed for the Cycle 8 core design described herein. (Author).

6646 (KAERI/TR–362/93) **Development of an emergency operation supporting system, KOSSN.** Park, Chang Kue (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Yang, Joon On; Jeong, Kwang Sub. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jul 1993. 42p. (In Korean). Order Number DE94610772. Source: OSTI; NTIS (US Sales Only); INIS.

To support the emergency operation of the nuclear power plants (NPP), Korea Atomic Energy Research Institute (KAERI) has been developing an operation supporting system called KOSSN (KAERI Operation Supporting System for NPP). KOSSN provides the operator with very detailed action items which are derived from the Emergency Operating Procedures (EOPs). The artificial intelligence (AI) and the probabilistic safety assessment (PSA) techniques are used in developintg KOSSN. It consists of three parts: The operator action items for the emergency operation of NPP are provided in the first part. The second part of KOSSN generates the success paths of the safety systems which can be used for the operator to restore the challenged safety functions and rank them according to the respective operability. In the last part, according to the present plant status, the appropriate event tree is suggested to the operator in order to show the possible future courses of accident progression. For the detailed man-machine interface, a color graphic display is utilized. KOSSN is built on a workstation using the IF-Prolog language and the X11 graphic tool. (Author).

2201 Theory and Calculation

Refer also to citation(s) 6628, 6710, 6735, 7948

6647 (Juel–2739) **The depletion computer code ORIGEN-JUEL-II.** Ruetten, H.J. Forschungszentrum Juelich GmbH (Germany). Inst. fuer Sicherheitsforschung und Reaktortechnik. Mar 1993. 44p. Order Number DE94733998. Source: OSTI; NTIS (US Sales Only); INIS.

The ORIGEN-JUeL-II in its basic calculating method is derived from the ORNL point depletion code ORIGEN. The advanced JUeL-II-version can make use of irradiation-histogram data of fuel batches given in the form of multigroup cross sections and multigroup neutron fluxes, both varying with time during the irradiation period of the fuel. A high flexibility in processing nuclear data enables the user to determine, to which extend will substitute the nuclear data of the ORIGEN-libraries by his own, externally generated multigroup cross sections. He may decide, how much to go into detail, describing the time-dependent change not only of the height but also of the spectrum of the neutron flux. As results the user may obtain the radioactivity of the fuel, the decay power, hazards of incorporation, γ-spectra and neutron sources at any point in time during the in-core irradiation as well as the properties of spent fuel during the periods of fuel storage, obtaining an improved degree of accuracy. The JUeL-II-specific application mode of the code is restricted to nuclear facilities having a thermal neutron spectrum. (orig.)

6648 (KAERI/TR–305/92) **Reactivity coefficients model for the steamline break accidents (2 loop plant).** Um, Kil Sup (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Kim, Hee Cheol; Jung, Yil Sup; Park, Jong Ryul; Lee, Chong Chul; Paek, Ju Hyun; Zee, Sung Kyun. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Sep 1992. 21p. (In Korean). Order Number DE94610773. Source: OSTI; NTIS (US Sales Only); INIS.

For a 3-loop plant, a new reactivity model which is easily applicable in evaluating the safety of hot zero power steamline break accident was established. The applicability of this reactivity model for a 2-loop plant has been examined. As per the result, the weighting for the core inlet average density is optimized to be 0.8 and 0.2 respectively for each of a cold and a hot loop. Also, it is verified that the safety analysis reactivity coefficients suggested in this model are enoughly conservative as compared with the best-estimated reactivity coefficients. These results demonstrate that the established reactivity model for a 3-loop plant is applicable to a 2-loop plant. (Author).

6649 (KAERI/TR–319/92) **Benchmark calculations of AMPX-KENO code at various moderator densities.** Ahn, Dawk Hwan (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Ahn, Joon Gi; Kim, Hyeong Heon; Lee, Seong Hee; Hwang, Hae Ryong. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Nov 1992. 21p. (In Korean). Order Number DE94610774. Source: OSTI; NTIS (US Sales Only); INIS.

Benchmark calculations of AMPX-KENO computer code system were performed to validate this code system for the criticality analysis of the new fuel storage rack. The critical experiments to study the effect due to the interpositioning of hydrogeneous materials between assembly (study connected with the problems raised by the accidental springkling of a mist into a fuel storage) were selected as the reference of the benchmark calculations. The comparsion of the results between the experiment and the calculation shows a good agreement. The bias and uncertainties were also obtained from the benchmark calculations. (Author).

6650 (KFKI–1993-02/G) **Anomaly detection in OECD Benchmark data using co-variance methods.** Srinivasan, G.S. (Indira Gandhi Centre for Atomic Research, Kalpakkam (India)); Krinizs, K.; Por, G. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Feb 1993. 29p. Order Number DE94610775. Source: OSTI; NTIS (US Sales Only); INIS

OECD Benchmark data distributed for the SMORN VI Specialists Meeting in Reactor Noise were investigated for anomaly detection in artificially generated reactor noise benchmark analysis. It was observed that statistical features extracted from covariance matrix of frequency components are very sensitive in terms of the anomaly detection level. It is possible to create well defined alarm levels. (R.P.) 5 refs.; 23 figs.; 1 tab.

6651 (WAPD-T–2949) **Analysis of benchmark critical experiments with ENDF/B-VI data sets.** Hardy, J. Jr.; Kahler, A.C. Bettis Atomic Power Lab., West Mifflin, PA (United States). [1991]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-910414–43: International topical meeting on advances in mathematics, computation and reactor physics, Pittsburgh, PA (United States), 28 Apr - 2 may 1991). Order Number DE94004450. Source: OSTI; NTIS; INIS; GPO Dep.

Several clean critical experiments were analyzed with ENDF/B-VI data to assess the adequacy of the data for U^{235}, U^{238} and oxygen. These experiments were (1) a set of homogeneous U^{235}-H_2O assemblies spanning a wide range of hydrogen/uranium ratio, and (2) TRX-1, a simple, H_2O-moderated Bettis lattice of slightly-enriched uranium metal rods. The analyses used the Monte Carlo program RCP01, with explicit three-dimensional geometry and detailed representation of cross sections. For the homogeneous criticals, calculated k_{crit} values for large, thermal assemblies show good agreement with experiment. This supports the evaluated thermal criticality parameters for U^{235}. However, for assemblies with smaller H/U ratios, k_{crit} values increase significantly with increasing leakage and flux-spectrum hardness. These trends suggest that leakage is underpredicted and that the resonance eta of the ENDF/B-VI U^{235} is too large. For TRX-1, reasonably good agreement is found with measured lattice parameters (reaction-rate ratios). Of primary interest is rho28, the ratio of above-thermal to thermal U^{238} capture. Calculated rho28 is 2.3 ($\pm$ 1.7) % above measurement,

suggesting that U^{238} resonance capture remains slightly overpredicted with ENDF/B-VI. However, agreement is better than observed with earlier versions of ENDF/B.

2202 Components and Accessories

Refer also to citation(s) 6637, 6648, 6677, 6680, 6682, 6702, 6703, 6721, 6722, 6723, 6727, 6731, 6746, 6960, 6995

6652 (CONF-931079–13) **Biaxial loading and shallow-flaw effects on crack-tip constraint and fracture-toughness.** Pennell, W.E.; Bass, B.R.; Bryson, J.W.; McAfee, W.J.; Theiss, T.J.; Rao, M.C. Oak Ridge National Lab., TN (United States). [1993]. 25p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC05-84OR21400. From Water reactor safety information meeting; Bethesda, MD (United States); 25-27 Oct 1993. Order Number DE94003496. Source: OSTI; NTIS; INIS; GPO Dep.

Uniaxial tests of single-edged notched bend (SENB) specimens with both deep- and shallow-flaws have shown elevated fracture-toughness for the shallow flaws. The elevation in fracture-toughness for shallow flaws has been shown to be the result of reduced constraint at the crack-tip. Biaxial loading has the potential to increase constraint at the crack-tip and thereby reduce some of the shallow-flaw, fracture-toughness elevation. Biaxial fracture-toughness tests have shown that the shallow-flaw, fracture-toughness elevation is reduced but not eliminated by biaxial loading. Dual-parameter, fracture-toughness correlations have been proposed to reflect the effect of crack-tip constraint on fracture-toughness. Test results from the uniaxial and biaxial tests were analyzed using the dual-parameter technology. Discrepancies between analysis results and cleavage initiation site data from fractographic examinations indicate that the analysis models are in need of further refinement. Addition of a precleavage, ductile-tearing element to the analysis model has the potential to resolve the noted discrepancies.

6653 (KAERI/AR–371/93) **The selection of pumps and valves for an optimum system performance.** Bae, Yoon Yeong (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)). Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). May 1993. 119p. (In Korean). Order Number DE94610777. Source: OSTI; NTIS (US Sales Only); INIS.

This report summarizes basic reference information for system engineers. Explanation on friction loss in pipes and graphical and tabulated design informations are presented for engineers' use in everyday design work. Since pumps and valves are the most important components, selection method and their relations with systems are emphasized. For pumps, basic theory is briefly presented first, followed by their relation with the systems. Seismic requirement for pump is discussed since most pumps installed in NSSS are designed in accordance with ASME Code, which requires the pump to be seismically qualified. Minimum flow line required to protect pump from overheating when the pump experiences shutoff head, is also discussed. Since most of the pumps are driven by motor, some knowledge on the motor is required for system designer. Protection method, starting method, and relation with system is presented. For valves, basic functions and configurations are summarized. Since flow medium of NSSS valves and pumps is boric acid the basic construction material is austenitic stainless steel. Valve seat material is Stellite hardfaced austenitic stainless steel. Cobalt 60 with long half life is produced when Cobalt 59 from Stellite migrates to Reactor Coolant Pressure Boundary. Valve manufacturers are investigating new substitutes. Test result for the new material from Anchor/Darling is presented. Factor which affects valve selection is cavitation. Since valve performance assurance and system performance are largely impacted by this single factor, it is discussed. The trim determines control valve performance. Relation between trim and flow characteristic is explained. Flowchart for valve selection is presented. Finally, an example of pump and valve selection for the boiler feedwater system is presented, which reminds system designer that economic consideration must be included in system design. (Author).

6654 (KAERI/TR–273/92) **Study on development and assessment of severe accident management strategies.** Kim, Hee Dong (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Park, Rae Joon. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jun 1992. 121p. (In Korean). Order Number DE94610778. Source: OSTI; NTIS (US Sales Only); INIS.

There have been numerous studies for devising various strategies of accident prevention and mitigation on postulated severe accidents that may lead to core damage and ultimately to containment failure. The current study is focused on depressurization of the Reactor Coolant System (RCS) through opening of pressurizer Power Operated Relief Valves (PORVs) in the TMLB' sequence and through the secondary side depressurization in the SBLOCA without HPSI sequence. The effectiveness of this accident management strategy has been investigated using SCDAP/RELAP5 and RELAP5 computer codes for the Kori Nuclear Power Plant Unit 1 (KNU 1). (Author).

6655 (KAERI/TR–275/92) **Study on severe fuel damage and in-vessel melt progression.** Kim, Hee Dong (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Kim, Sang Baik; Lee, Gyu Jung. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jun 1992. 145p. (In Korean). Order Number DE94610779. Source: OSTI; NTIS (US Sales Only); INIS.

In-vessel core melt progression describes the progression of the state of a reactor core from core uncovery up to reactor vessel melt through in uncovered accidents or through temperature stabilization in accidents recovered by core reflooding. Melt progression can be thought as two parts; early melt progression and late melt progression. Early phase of core melt progression includes the progression of core material melting and relocation, which mostly consist of metallic materials. On the other hand, the late phase of core melt progression involves ceramic material melt and relocation to the lower plenum and heat-up the reactor vessel lower head. A large number of information are available for the early melt progression through experiments such as SFD, DF, FLHT test and utilized in the severe accident analysis codes. However, understanding of the late phase melt progression phenomenology is based primary on TMI-2 core examinations and not much experimental information is available. Especially, the great uncertainties exist in vessel failure mode, melt composition, mass, and temperature. Further research is planned to perform to reduce the uncertainties in understanding of core melt down accidents as parts of long term melt progression research program. A study on the core melt progression at KAERI has been being performed through the Severe Accident Research Program with USNRC. KAERI staff had participated in the PBF SFD experiments at INEL and analyses of experiments were performed using SCDAP code. Experiments of core melt program have not been carried out at KAERI yet. It is planned that further research on core melt down accidents will be performed, which is related to design of future generations of nuclear reactors as parts of long-term project for improvement of nuclear reactor safety. (Author).

6656 (KAERI/TR–345/93) **Development of an automatic steam generator level control logic at low power operations.** Seo, Jong Tae (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Sohn, Jong Joo; Seo, Ho Taek; Ko, Chang Seog; Kim, Chong Hoon; Ro, Tae Sun. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). May 1993. 70p. (In Korean). Order Number DE94610780. Source: OSTI; NTIS (US Sales Only); INIS.

The main objective of this research is to develop a new feedwater control logic for Ulchin Nuclear Power Plant Unit 3~4 (UCN 3~4) by incorporating the steam generator level control concept utilized in the UCN 1~2 which have demonstrated their capability of automatic level control at low power levels. The new control concepts adopted from UCN 1~2 are the steam generator level compensation by the feedwater temperature, the variable level set-point program according to the turbine power, and the two element control scheme at low power levels. The results demonstrated that a stable steam generator level control is possible with the new feedwater control logic at power levels lower than 15%. Therefore, it is highly possible to improve the performance and safety of the UCN 3~4 provided that a further research develops a complete feedwater control system logic applicable to the entire power range and investigates the impact of adopting the new control logic on the system design. (Author).

6657 (LA-UR-93-3462) **Empirical Bayes estimation of the average reliability of nuclear power plant emergency diesel generators to load-run upon demand.** Martz, H.F. (Los Alamos National Lab., NM (United States)); Abramson, L.R. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-36. Contract FIN L1836-3. (CONF-940312--7: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94000686. Source: OSTI; NTIS; INIS; GPO Dep.

If offsite power is interrupted, the availability of onsite alternating current power supplies is a major factor in assuring acceptable safety at commercial light-water-cooled nuclear power plants. To control the risk of severe core damage during station blackout accidents at a given plant, the reliability of the emergency diesel generators (EDGs) to load-run upon demand must be maintained at a sufficiently high level. The minimum EDG reliability is targeted at either 0.95 or 0.975 per nuclear unit consistent with the reliability level that the plant operator assumed in the coping analysis for station blackout. Because the reliability of the EDGs is critical to safety, it is important to estimate this reliability as accurately as possible. We are also interested in comparing the estimates to the target reliability values. In soliciting public comment on the target reliability levels, the US Nuclear Regulatory Commission (NRC) asked the following question [SECY-93-044 (1993)]: Is there a method which could utilize industry-wide EDG performance experience to estimate EDG reliability, while providing adequate reliability degradation information for plant specific use? As we shall see, empirical Bayes (EB) is one such method; thus, the answer to the question is affirmative, and this report provides a discussion of this method.

6658 (NUREG--1377-Rev.4) **NRC Research Program on Plant Aging: Listing and summaries of reports issued through September 1993: Revision 4.** Vora, J.P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Engineering. Dec 1993. 108p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS.

The US Nuclear Regulatory Commission is conducting the Nuclear Plant Aging Research (NPAR) Program. This is a comprehensive hardware-oriented engineering research program focused on understanding the aging mechanisms of components and systems in nuclear power plants. The NPAR program also focuses on methods for simulating and monitoring the aging-related degradation of these components and systems. In addition, it provides recommendations for effective maintenance to manage aging and for implementation of the research results in the regulatory process. This document contains a listing and index of reports generated in the NPAR Program that were issued through September 1993 and summaries of those reports. Each summary describes the elements of the research covered in the report and outlines the significant results. For the convenience of the user, the reports are indexed by personal author, corporate author, and subject.

6659 (NUREG/CP--0134, pp. 69-87) **Cable aging tests.** Hubbard, G. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215--: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper describes the results from aging, condition monitoring, and loss-of-coolant accident (LOCA) testing of class 1E electrical cables, per NUREG/CR-5772. This test was designed to test the performance of cables which had been aged with simultaneous radiation and thermal exposure. The tested cables included crosslinked polyolefin cables, ethylene propylene rubber cables, and miscellaneous cable types. Cables were exposed to 20, 40, and 60 years equivalent aging, and then exposed to LOCA tests at the end of their qualified life to determine the minimum insulation thickness needed for survival of the test. Failures were found in a large number of the tested cables. As a result the NRC has sent information notices to the industry regarding potential insulation problems. The results have raised the question of whether the artificial aging methods provide adequate testing methods. As a result of this testing the NRC is reviewing the artificial aging procedures, the adequacy of environmental qualification requirements for cable safety, and reexamining data from condition monitoring of installed cables.

6660 (NUREG/CP--0134, pp. 89-147) **In-situ measurement of response time of RTDs and pressure transmitters in nuclear power plants.** Hashemian, H.M. (Analysis and Measurement Services Corp., Knoxville, TN (United States)); Riner, J.L. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215--: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

Response time measurements are performed once every fuel cycle on most safety-related temperature and pressure sensors in a majority of nuclear power plants in the US. This paper provides a review of the methods that are used for these measurements. The methods are referred to as the Loop Current Step Response (LCSR) test, which is used for response time testing of temperature sensors, and noise analysis and power interrupt (PI) tests, which are used for response time testing of pressure, level, and flow transmitters.

6661 (NUREG/CP--0134, pp. 149-156) **Pilot studies of management of ageing of nuclear power plant instrumentation and control components.** Burnay, S.G. (AEA Technology, Oxfordshire (United Kingdom)); Simola, K.; Kossilov, A.; Pachner, J. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215--: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper describes pilot studies which have been implemented to study the aging behavior of safety related component parts of nuclear power plants. In 1989 the IAEA initiated work on pilot studies related to the aging of such components. Four components were identified for study. They are the primary nozzle of a reactor vessel; a motor operated isolating valve; the concrete containment building; and instrumentation and control cables within the containment facility. The study was begun with phase 1 efforts directed toward understanding the aging process, and methods for monitoring and minimizing the effects of aging. Phase 2 efforts are directed toward aging studies, documentation of the ideas put forward, and research to answer questions identified in phase 1. This paper describes progress made on two of these components, namely the motor operated isolation valves, and in-containment I&C cables.

6662 (NUREG/CP--0134, pp. 157-208) **Effects of normal aging on calibration and response time of nuclear plant RTDs and pressure sensors.** Hashemian, H.L. (Analysis and Measurement Services Corp., Knoxville, TN (United States)); Riner, J.L. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215--:

IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

Resistance temperature detectors (RTDs) and pressure, level, and flow transmitters provide a majority of the vital signals for the control and safety of nuclear power plants. Therefore, it is crucial to ensure that the performance of these sensors are maintained at an acceptable level while the plant is operating. Since aging has the potential to cause performance degradation in RTDs and pressure transmitters, several research projects have been sponsored by the US Nuclear Regulatory Commission (NRC) to study the aging characteristics of these sensors and ensure that adequate test methods and test frequencies are followed by the nuclear industry to ensure safety. The details of these projects are summarized in this paper.

6663 (NUREG/CP–0134, pp. 209-261) **Validation of on-line monitoring techniques for in-situ testing of calibration drift of process instrumentation channels in nuclear power plants.** Hashemian, H.M. (Analysis and Measurement Services Corp., Knoxville, TN (United States)); Mitchell, D.W.; Antonescu, C.E.; Mauck, J. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper reports on the progress of a research and development (R&D) project which is underway to provide an assessment of the validity of the on-line monitoring techniques for instrument calibration reduction in nuclear power plants. Both laboratory and in-plant validation work on typical nuclear plant instrumentation channels are being conducted under this project. The laboratory validation tests are performed in a test loop in which a number of nuclear grade temperature and pressure sensors have been installed and connected to a Westinghouse Model 7300 instrumentation system of the type used in Pressurized Water Reactors (PWRs). The loop is used to determine if simulated drift in the sensors can be effectively detected by on-line monitoring methods. It is also used for verification and validation of on-line monitoring software packages being developed as a part of this project. The in-plant validation work is being performed at the McGuire Nuclear Power Station where 170 process signals are being monitored under normal operating conditions. The signals are being recorded for an entire fuel cycle and analyzed to identify any channels that may have drifted out of tolerance during the fuel cycle. The results of this work will be compared with the results of the conventional hands-on calibrations that are normally performed at refueling outages. This comparison will help determine if on-line monitoring techniques can identify the same drift that is detected by conventional calibrations. The results of the laboratory and in-plant research completed to date have shown that on-line drift monitoring should be a successful tool for isolating the instrument channels that must be calibrated. This will help limit the calibration activity to only those channels which need to be calibrated as opposed to calibrating all safety-related channels, as is presently being done.

6664 (NUREG/CP–0134, pp. 263-275) **Predictive maintenance of electrical components through computer-controlled acquisition and trending of standard circuit parameters.** Allan, G. (ECAD, Coraopolis, PA (United States)); Weir, T.J. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

Condition monitoring techniques are finding greater acceptance within many power plant maintenance organizations as plant operators develop predictive maintenance programs. This paper describes a proven condition monitoring technique and it's application in an electrical circuit predictive maintenance program. The technique performs a series of standard electrical measurements, under computer control, using a pre-defined test methodology. The test data is evaluated by utilizing statistical analysis methods and by comparisons through graphical representations. These methods allow comparisons with data from similar circuits or with baseline measurements. Circuit and component degradation appears as a change in one or more of the measured electrical parameters. Trending these parameters over time provides for early identification of circuit degradation. Incorporating this technique into a plant predictive maintenance program will switch maintenance personnel from a reactive to proactive position.

6665 (NUREG/CP–0134, pp. 277-284) **The effects of aging on electrical and I&C components: Results of US Nuclear Plant Aging Research.** Aggarwal, S.K. (Nuclear Regulatory Commission, Washington, DC (United States)); Gunther, W.E. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

The US NRC's hardware oriented engineering research program for plant aging and degradation monitoring has achieved results in the area of electrical, control, and instrumentation (ECI) components used in nuclear power plants (NPPs). The principal goals of the program, known as the Nuclear Power Plant Aging Research (NPAR) Program, are to understand the effects of age-related degradation in NPPs and how to manage and mitigate them effectively. This paper describes how these goals have been achieved for key ECI components used in the safety systems of NPPs. The status of relevant on-going and planned research projects is also provided.

6666 (NUREG/CP–0134, pp. 285-304) **Rosemount transmitters – supplement to Bulletin 90-01.** Spaulding, D. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This article summarizes the issues surrounding the issuance of NRC information notice 90-01, and its recently released supplement. Notice 90-01 was issued to deal with a problem detected in the performance of Rosemount model 1153 and 1154 pressure and differential pressure transmitters which are used in different reactor protection trip circuits, etc. The problem was identified as a slow leak of fill oil which caused a gradual failure of the sensor. Because of a requirement that such components meet current criteria as a reliable component for which failures can be readily detected, NRC staff has closely monitored responses to this original notice. As a result of these concerns a supplement has been

issued to the original notice which requests power plant license holders to subject these devices to more stringent testing procedures while they remain in/or are brought into service.

6667 (NUREG/CP–0134, pp. 307-313) **Account of requirements for modernization in VPBER-600 enhanced safety reactor instrumentation and control system development.** Shashkin, S.L. (OKBMechanical Engineering, Nizhny Novgorod (Russian Federation)); Pobedonostsev, A.B.; Drumov, V.V.; Chudin, A.G. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

Nuclear power plant (NPP) with VPBER-600 reactor is a station of new generation. The specified term of reactor plant operation is 60 years and taking into account that the proposed term of starting the first power unit is on the turn of centuries one can definitely state that for Russia conditions VPBER-600 is a plant of 21 century. Such far removed term for NPP now in the stage of development as it can seem does not put the problems of modernization as first order tasks. But "...who does not think about future lives in the past." It is that the NPP instrumentation and control (I&C) systems are in the most degree subjected to the influence of factors which favor their modifications. These factors can be arbitrarily divided into two groups: (1) inner factors, i.e. changes (failures, aging, etc) in I&C components as well as changes dictated by technological reasons (change of equipment composition, control algorithms, operation modes); (2) outer factors, i.e. intensive development of information technologies and rapid improvement of electronic components. This presentation addresses the problem of modernization of the safety instrumentation for this next generation facility, and the research effort it will entail. The system is designed to allow for modernization, and the relatively easy adoption of new instrumentation and technology as it becomes available.

6668 (NUREG/CP–0134, pp. 315-331) **Regulatory requirements for replacement of analog systems with digital upgrades.** Loeser, P.J. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper reviews briefly the regulatory guidelines which must be met in order to replace analog systems in nuclear power plants with digital systems. There is a move to do such replacements for a number of reasons: analog systems are aging, and showing considerable drift; few vendors manufacture analog systems today; support and parts are hard to get; digital systems provide flexibility. There is a safety concern however about undesirable and unpredictable effects to digital safety equipment due to plant transients, accidents, post-accident condition, and EMI/RF environmental interferences. License holders must comply with the requirements of 10 C.F.R. 50.59, which deals with safety concerns with respect to any changes to operating plants which may have an impact on the safety of the plant. NRC staff is taking the position that all digital upgrades will require an evaluation under this regulation.

6669 (NUREG/CP–0134, pp. 335-347) **Addressing the susceptibility of digital systems to electromagnetic interference.** Ewing, P.D. (Oak Ridge National Lab., TN (United States)); Korsah, K.; Antonescu, C. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. DOE Contract AC05-84OR21400. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper discusses the development of the technical basis for acceptance criteria applicable to the immunization of digital systems against electromagnetic interference (EMI). The work is sponsored by the US Nuclear Regulatory Commission and stems from the safety-related issues that need to be addressed as a result of the application of digital instrumentation and control systems in nuclear power plants. Designers of digital circuits are incorporating increasingly higher clock frequencies and lower logic level voltages, thereby leading to potentially greater susceptibility of spurious interference being misinterpreted as legitimate logic. Development of the technical basis for acceptance criteria to apply to these digital systems centers around establishing good engineering practices to ensure that sufficient levels of electromagnetic compatibility (EMC) are maintained between the nuclear power plant's electronic and electromechanical systems. First, good EMC design and installation practices are needed to control the emissions from interference sources and thereby their impact on other nearby circuits and systems. Second, a verification and validation (V&V) program is needed to outline the EMI tests to be performed, the associated test methods to be followed, and adequate acceptance should be followed by periodic maintenance to assess whether the recommended EMI control practices continue to be adhered to as part of the routine operation of the nuclear power plant. By following these steps, the probability of encountering safety-related instrumentation susceptibility attributable to EMI will be greatly reduced.

6670 (SAND–93-1606C) **Experiments to evaluate behavior of containment piping bellows under severe accident conditions.** Lambert, L.D.; Parks, M.B. Sandia National Labs., Albuquerque, NM (United States). 1993. 24p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931079–9: Water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). Order Number DE94003106. Source: OSTI; NTIS; INIS; GPO Dep.

Bellows are an integral part of the containment pressure boundary in nuclear power plants. They are used at piping penetrations to allow relative movement between piping and the containment wall. In a severe accident they may be subjected to high pressure and temperature, and a combination of axial and lateral deflections. A test program to determine the leak-tight capacity of containment penetration bellows is being conducted at Sandia National Laboratories, Albuquerque, New Mexico. Several different bellows geometries, representative of actual containment bellows, are being subjected to extreme deflections along with pressure and temperature loads. The bellows geometries and loading conditions are described along with the testing apparatus and procedures. A total of thirteen tests have been conducted. The tests showed that withstanding relatively large bellows are capable of deformations, up to, or near, the point of full compression before developing leakage. The test data is presented and discussed.

2203 Fuel Elements

Refer also to citation(s) 6324, 6606, 6693

6671 (KAERI/TR–248/92) **Debris filtering effectiveness and pressure drop tests of debris resistance-bottom end piece.** Chung, Moon Ki (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Song, Chul Hwa; Chung, Heung June; Won, Soon Yeun; Cho, Young Ro; Kim, Bok Deuk. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Mar 1992. 64p. Order Number DE94610790. Source: OSTI; NTIS (US Sales Only); INIS.

In this final report, described are the test conditions and test procedures for the debris filtering effectiveness and pressure drop tests for developing the Debris Resistance-Bottom End Piece (DR-BEP). And the test results are tabulated for later evaluation. (Author).

6672 (KAERI/TR–286/92) **KMRR fuel design.** Son, D.S. (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Sim, B.S.; Kim, T.R.; Hwang, W.; Kim, B.G.; Ku, Y.H.; Lee, C.B.; Lim, I.C. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jun 1992. 60p. (In Korean). Order Number DE94610792. Source: OSTI; NTIS (US Sales Only); INIS.

KMRR fuel rod design criteria on fuel swelling, blistering and oxide spallation have been reexamined. Fuel centerline temperature limit of 250deg C in normal operation condition and fuel swelling limit of 12 % at the end of life have been proposed to prevent fuel failure due to excessive fuel swelling. Fuel temperature limit of 485deg C has been proposed to exclude the possibility of fuel failures during transients or under accident condition. Further analyses are needed to decide the fuel cladding temperature limit to preclude the oxide spallation. Design changes in fuel assembly structure and their effects on related systems have been reviewed from a structural integrity viewpoint. The remained works in fuel mechanical design area have been identified and further efforts of fuel design group will be focused on these aspects. (Author).

6673 (KAERI/TR–330/92) **The calculation of volume and mass of the 16x16 type KOFA components.** Song, Kee Nam (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Lee, Chang Woo. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jan 1993. 125p. (In Korean). Order Number DE94610793. Source: OSTI; NTIS (US Sales Only); INIS.

A systematic procedure for the calculation of the mass and volume of the 16x16 type KOFA components has been established in this report. In addition the mass for the fuel assembly components from the commercial products has been measured and compared with the calculation results. (Author).

2204 Control Systems

Refer also to citation(s) 6597, 6617, 6618, 6619, 6621, 6641, 6656, 6659, 6660, 6661, 6662, 6663, 6664, 6665, 6666, 6667, 6668, 6669, 6695, 6696

6674 (KAERI/AR–362/93) **A survey on the technologies and cases for the cognitive models of nuclear power plant operators.** Lee, Yong Hee (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Chun, Se Woo; Seo, Sang Moon; Lee, Hyun Chul. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Apr 1993. 152p. (In Korean). Order Number DE94610796. Source: OSTI; NTIS (US Sales Only); INIS.

To enhance the safety and availability of nuclear power plants, it is necessary to develop the methodologies which can systematically analyze the interrelationships between plant operators and main process systems. Operator congnitive models enable to provide an explicit method to analyze how operator's congitive behavior reacts to the behavior of system changes. However, because no adequate model has been developed up to now, it is difficult to take an effective approach for the review, assessment and improvement of human factors. In this study, we have surveyed the techniques and the cases of operator model development, aiming to develop an operator's model as one of human engineering application methodologies. We have analyzed the cognitive characteristics of decision-making, which is one of the principal factors for modeling, and reviewed the methodologies and implementation thechniques used in the cases of the model development. We investigated the tendencies of the model developments by reviewing ten cases and especially CES, INTEROPS and COSIMO models which have been developed or are under development in nuclear fields. Also, we summarized the cognitive characteristics to be considered in the modeling for the purpose of modeling operator's decision-making. For modeling methodologies, we found a trend of the modeling that is software simulations based on the artificial intelligence technologies, especially focused in knowledge representation methods. Based on the results of our survey, we proposed a development approach and several urgent research subjects. We suggested the development simulation tools which can be applicable to the review, assessment and improvement of human factors, by implementing them as softwares using expert system development tools. The results of this study have been applied to our long-term project named 'The Development of Human Engineering Technologies.' (Author).

6675 (KAERI/TR–299/92) **Development of an expert system for success path generation and operator's action guides in NPP: Verification and validation of COSMOS.** Yang, Jun Un (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Jung, Kwang Sup; Park, Chang Gyu. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Aug 1992. 17p. Order Number DE94610797. Source: OSTI; NTIS (US Sales Only); INIS.

For the support of emergency operation, an expert system named COSMOS (COmputerized Success-path MOnitoring System) is being developed at Korea Atomic Energy Research Institute (KAERI). COSMOS identifies the critical safety function's (CSF'S) status, and suggests the overall response strategy with a set of success paths which restore the challenged CSF's. The status of CSF is identified by the rule-based reasoning. The overall response strategy is inferred according to the identified CSF's status. The success paths are generated by the given structure descriptions of systems and the general generation algorithm. For efficient man-machine interface, a colar graphic display is utilized. COSMOS is being built on a workstation. The major tasks to build an expert system such as COSMOS are the construction of knowledge base and inference engine. In COSMOS, the knowledges are derived from the Emergency Operating Procedures (EOPs), and the forward chaining is adopted as the inference strategy. While the knowledge base and inference engine are the most common and essential elements of an expert system, they are not the only ones. The evaluation of expert systems can not only lessen the risk of using faulty software, but also enhance the acceptability of the expert systems by both users and regulators. The evaluation of expert systems consists of the system verification, validation and user acceptance testing. Among them, in this report, we have focused our attention to verification and validation (V≃V) of expert systems. We have accessed the general V≃V procedures and tried to develop the specific V≃V procedure for COSMOS. (Author).

6676 (NUREG/CP–0134, pp. 11-20) **Computer software review procedures.** Mauck, J.L. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability*. 577p. Source: OSTI; NTIS; INIS; GPO.

This article reviews the procedures which are used to review software written for computer based instrumentation and control functions in nuclear facilities. The utilization of computer based control systems is becoming much more prevalent in such installations, in addition to being retrofit into existing systems. Currently, the Nuclear Regulatory System uses Regulatory Guide 1.152, "Criteria for Programmable Digital Computer System Software in Safety-Related Systems of Nuclear Power Plants" and ANSI/IEEE-ANS-7-4.3.2-1982, "Application Criteria for Programmable Digital Computer Systems in Safety Systems of Nuclear Power Generating Stations" for guidance when performing reviews of digital systems. There is great concern about the process of verification and validation of these codes, so when inspections are done of such systems, inspectors examine very closely the processes which were followed in developing the codes, the errors which were detected, how they were found, and the analysis which went into tracing down the causes behind the errors to insure such errors were not propagated again in the future.

6677 (NUREG/CP–0134, pp. 21-34) **US utility I&C upgrade initiative.** Wilkinson, D. (Electric Power Reasearch Inst., Palo Alto,

CA (United States)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215--: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper describes an initiative which is being pursued to address the problems associated with the increasing obsolescence of instrumentation and control (I&C) systems in nuclear power plants. Such efforts will improve safety, availability, and reliability of plant operation. The program presented is a joint plan between EPRI, utilities, and vendors, to bring about the development of technology to meet these needs, to encourage the private sector to develop such technology, and to prove to utilities the value and utility in applying such technology to upgrade their facilities. Part of this plan is demonstration programs where plant-wide sensor and I&C improvements can be implemented, in a documented manner, to provide R&D information on their performance, functionality, and reliability. The intent is to reduce the costs and shorten the learning curve associated with the utilization of modern I&C equipment.

6678 (NUREG/CP--0134, pp. 393-404) **Experience in installing a microprocessor-based protection system on a UK nuclear power plant.** Jones, C.D. (Nuclear Electric plc, Kent (United Kingdom)); Smith, I.C. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215--: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper describes a recently completed project to install a microprocessor-based reactor protection system on a twin reactor station in the United Kingdom. This represented the first application of digital technology as part of such a system in the UK. The background of the application and details of the chosen solution are provided. The experience gained during the installation, commissioning and early operation of the equipment is reviewed by the operators. Interactions between the utility and the regulatory body are outlined and the impact of the regulatory process on the utility's resources and the project timescales are discussed.

6679 (NUREG/CP--0134, pp. 421-459) **Strategy to safety grade systems replacements.** Stimler, M. (Siemens Power Corp., Bradenton, FL (United States)); Sullivan, K.E.; Trebincevic, I. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215--: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

The introduction of digital instrumentation and control systems in nuclear power plants is characterized by the need to satisfy the requirements of safety, reliability and man-machine ergonomics. Today digital instrumentation and control systems meet these requirements and the trend in Europe is towards full digital based nuclear power plant control systems. This paper describes Siemens (KWU) experience in nuclear power plants and development in trends within Europe. Topics which are the subject of major concern to NPP operators addressed in this paper are: human performance factors - man-machine interface; operating philosophy; safety, availability and reliability. Other aspects addressed are: Siemens "defense in depth" concept, description of Siemens digital I&C systems, safety requirements and systems, I&C qualification, control room ergonomics, information systems and retrofitting experience.

6680 (NUREG/CP--0134, pp. 489-502) **The role of international standards in the design of modern I&C systems for nuclear power plants.** Gallagher, J.M. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215--: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper begins with a historical perspective on the International Electrotechnical Commission (IEC), the International Organization for Standardization (ISO), and their technical committees IEC TC 45 and ISO TC 85, which have developed mutual agreements to avoid duplication of effort in standardization development for reactor instrumentation. In 1976 the International Atomic Energy Agency (IAEA) published safety standards and guides. In early 1981 agreements were reached between IAEA and IEC to avoid duplication of effort in regard to instrumentation and control systems used for protection, control, and monitoring nuclear power plants. Following these agreements, the IEC has made major efforts directed at development of I&C standards for nuclear power plants. The paper then reviews standards work relevant to NPP I&C systems. This has covered areas such as the application of digital computer control systems, classification and graded requirements for I&C systems important to safety, design efforts for the main control room, and advanced measurement and monitoring systems.

6681 (NUREG/CP--0134, pp. 505-514) **Software maintenance and re-validation for nuclear power plants.** Phoenix, R.G. (Rolls-Royce and Associates Ltd., Derby (United Kingdom)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215--: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

When designing a new I&C system, software can be developed using modern software engineering methods. However, existing systems cannot, by definition, have been developed using such techniques. Thus, consideration should be given to methods for maintaining aging software. Requirements for software changes can arise from several sources. Several problems can be encountered when becoming involved in maintaining aging software. Solutions to these problems come from the employment of modern software engineering techniques, including complete emulation of the original hardware, reverse/re-engineering and redesign. The choice of which technique(s) to use can depend on cost and whether it is possible to demonstrate the required integrity. Furthermore, the extent of modification, the likelihood of further changes and further maintenance problems can all have a bearing.

6682 (NUREG/CP--0134, pp. 515-529) **Reliability analysis of microprocessor-based control and protection systems in nuclear power plants.** Wiesemann, J.S. (Westinghouse Electric Corp., Pittsburgh, PA (United States)); Lang, G.E.; Remley, G.W. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric

Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper will present an overview of the objectives, methods, and limitations associated with the reliability assessment of microprocessor based control and protection systems being put into use today. The paper will be structured in a top down format presenting a general method which may be applied when assessing these types of systems. Specific discussion will be presented regarding current issues in the area of safety and licensing. Generic and unique methods which have been developed to assess these systems in a practical and efficient manner will be discussed, including discussion of the "Functional Block Analysis" method which may be used to predict the effectiveness of on-line checks and diagnostics. The models and results will be discussed. As a final note, general observations and findings regarding the typical performance of these systems, as demonstrated by the methods discussed, will be presented.

2205 Environmental Aspects

Refer also to citation(s) 6241, 6642, 6713, 6726, 6741

6683 (LA-UR–93-3548) **A procedure for assessing uncertainty in models.** McKay, M.D.; Beckman, R.J. Los Alamos National Lab., NM (United States). [1993]. 7p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–35: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94002627. Source: OSTI; NTIS; INIS; GPO Dep.

This paper discusses uncertainty in the output calculation of a model due to uncertainty in inputs values. Uncertainty in input values, characterized by suitable probability distributions, propagates through the model to a probability distribution of an output. Our objective in studying uncertainty is to identify a subset of inputs as being important in the sense that fixing them greatly reduces the uncertainty, or variability, in the output. The procedures we propose are demonstrated with an application of the model called MELCOR Accident Consequence Code System (MACCS), described in Helton et al. (1992). The purpose of MACCS is to simulate the impact of severe accidents at nuclear power plants on the surrounding environment. In any particular application of MACCS there are likely to be many possible inputs and outputs of interest. In this paper, attention focuses on a single output and 36 inputs. Our objective is to determine a subset of the 36 model inputs that can be said to be dominant, or important, in the sense that they are the principal contributors to uncertainty in the output.

6684 (RL-NRD–827) **Review of effluent disposal practices in N Reactor Department.** Stepnewski, D.D.; Hendrickson, M.M. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 28 Feb 1966. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003745. Source: OSTI; NTIS (US Sales Only); GPO Dep.

A survey has been conducted of current methods of disposal of radioactive, chemical, and sanitary wastes used both at the 100 Area and 300 Area sites of N Reactor Department Operations. In addition, liquid storage facilities have been surveyed for situations which might result in river water pollution. The survey and this report have been prepared in response to the request of the Manager, Richland Operations Office of the Atomic Energy Commission in accordance with Executive Order 11258. An audit of N Reactor Department waste disposal procedures and practices was recently made. The audit report provides detailed data on effluent streams, methods,d and sampling points. Therefore, this report does not include that information and instead provides a summary of experimental and analytical data which have become available since the audit. It also includes information developed in response to specific provisions set forth in the Executive Order.

2206 Research, Test, Training, Production, Irradiation, Materials Testing Reactors

Refer also to citation(s) 6120, 6172, 6175, 6684, 6721, 6745, 6746, 6747, 6748, 6749, 7322

6685 (ANL/EP/CP–81419) **Benchmark calculations for a heavy water research reactor using the WIMS-D4M code and a ENDF/B-V based library.** Mo, S.C. Argonne National Lab., IL (United States). [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310185–3: 16. international meeting on reduced enrichment for research and test reactors (RERTR), Ibaraki (Japan), 3-7 Oct 1993). Order Number DE94004629. Source: OSTI; NTIS; INIS; GPO Dep.

The results of unit-cell and global diffusion and transport calculations performed for the Georgia Tech heavy water research reactor using the WIMS-D4m code and a new ENDF/B-V based library are presented in this paper. Key cross sections, eigenvalues, neutron fluxes and peak power densities obtained from global diffusion calculations are compared.

6686 (ANL/EP/CP–81422) **Testing WIMS-D4M cross sections and the ANL ENDF/B-V 69 group library: Results from global diffusion and Monte Carlo calculations compared with measurements in the Romanian 14-MW TRIGA reactor.** Bretscher, M.M. Argonne National Lab., IL (United States). [1993]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310185–6: 16. international meeting on reduced enrichment for research and test reactors (RERTR), Ibaraki (Japan), 3-7 Oct 1993). Order Number DE94004612. Source: OSTI; NTIS; INIS; GPO Dep.

The WIMS-D4 code has been modified (WIMS-D4M) to produce microscopic isotopic cross sections in ISOTXS format for use in diffusion and transport calculations. Beginning with 69-group libraries based on ENDF/B-V data, numerous cell calculations have been made to prepare a set of broad group cross sections for use in diffusion calculations. Global calculations have been made for two control rod states of the Romanian steady state TRIGA reactor with 29 fresh HEU fuel clusters. Detailed Monte Carlo calculations also have been performed for the same reactor configurations using data based on ENDF/B-V. Results from these global calculations are compared with each other and with the measured excess reactivities. Although region-averaged macroscopic principal cross sections obtained from WIMS-D4M are in good agreement with the corresponding Monte Carlo values, problems exist with the high energy ($E > 10$ keV) microscopic hydrogen transport cross sections.

6687 (ANL/EP/CP–81441) **New ENDF/B-V nuclear data library for WIMS-D4M.** Deen, J.R. (Argonne National Lab., IL (United States)); Woodruff, W.L.; Costescu, C.I. Argonne National Lab., IL (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310185–7: 16. international meeting on reduced enrichment for research and test reactors (RERTR), Ibaraki (Japan), 3-7 Oct 1993). Order Number DE94004585. Source: OSTI; NTIS; INIS; GPO Dep.

The WIMS-D4M code has been chosen by the Reduced Enrichment for Research and Test Reactor (RERTR) Program for all future research reactor cross-section generation replacing EPRI-CELL. A new 69-group 96-material library has been created for use in WIMS-D4M. The latest SUN version of NJOY (91.27) was used to generate the ENDF/B-V-based cross-section library. The library also includes ENDF/B-V based fission yields, energy fission and energy per capture data. The upper energy boundary has been extended from 10 to 20 MeV in order to model high energy neutron reactions. Additional fuel and moderator temperatures have been included to better predict temperature coefficients. More excess potential scattering points have been added to increase the accuracy of self-shielded resonance cross-sections. Several benchmark comparisons have been made to validate the new library.

6688 (ANL/EP/CP–81464) **Post-irradiation examination of $U_3Si_{1.6}$-Al dispersion fuel element LC04.** Hofman, G.L. (Argonne National Lab., IL (United States)); Fanjas, Y.; Pruimboom, H.; Wijtsma, F. Argonne National Lab., IL (United States). [1993]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310185–4: 16. international meeting on reduced enrichment for research and test reactors (RERTR), Ibaraki (Japan), 3-7 Oct 1993). Order Number DE94004584. Source: OSTI; NTIS; INIS; GPO Dep.

A low-enrichment uranium (LEU) irradiation test (SIMONE project) was performed in the 45 MW Petten High-flux Reactor (HFR) as part of the Reduced Enrichment for Research and Test Reactor (RERTR) program. An LEU $U_3Si_{1.6}$-Al dispersion fuel element with a fuel loading of 5.5 g cm^{-3} was irradiated and performed well to a total burnup of 66% and a peak burnup of 85%. The swelling behavior of the fuel was similar to that observed in previous U_3Si_x irradiation experiments. The resulting fuel plate thickness increases and associated changes in coolant channel cross-sections were well within acceptable limits.

6689 (DOE/ER/12983–1) **Participation in the United States Department of Energy University Reactor Instrumentation Program: Final report, September 1990–August 1993.** Mulder, R.U.; Benneche, P.E.; Hosticka, B. Virginia Univ., Charlottesville, VA (United States). Dept. of Mechanical, Aerospace and Nuclear Engineering. Oct 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER12983. (UVA–527418/MANE94/101). Order Number DE94004928. Source: OSTI; NTIS; INIS; GPO Dep.

The University of Virginia Reactor Facility is an integral part of the Department of Mechanical, Aerospace and Nuclear Engineering and is used to support educational programs in engineering and science at the University of Virginia and at other area colleges and universities. The University of Virginia Research Reactor (UVAR) is the highest power (two megawatts thermal power) and one of the most utilized university research reactor in the mid-Atlantic states. A major objective of this facility is to support educational programs in the region. The University of Virginia has received support under the U.S. Department of Energy (DOE) University Reactor Instrumentation Program every year since 1990. The monies from this program have been used to purchase new equipment to replace outdated or inadequate safety-related instrumentation used in conjunction with reactor operations. This report documents the equipment purchased and the status of the installation and use of this equipment from September 1990 through August 1993. This report constitutes the final report for this project period.

6690 (DPSP–54-1-5-Del.Ver.) **[Monthly progress report for the Works Technical Department, May 1954].** Du Pont de Nemours (E.I.) and Co., Aiken, SC (United States). Savannah River Plant. 4 Jun 1954. 86p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. Order Number DE93016028. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report details activities of the Works Technical Department for the month of May 1954.

6691 (DPSP–54-1-6-Del.Ver.) **[Monthly progress report for the Works Technical Department, June 1954].** Du Pont de Nemours (E.I.) and Co., Aiken, SC (United States). Savannah River Plant. 7 Jul 1954. 99p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. Order Number DE93016027. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report details activities of the Works Technical Department for the month of June 1954.

6692 (DPSP–54-1-7-Del.Ver.) **[Monthly progress report for the Works Technical Department, July 1954].** Du Pont de Nemours (E.I.) and Co., Aiken, SC (United States). Savannah River Plant. 19 Aug 1954. 146p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. Order Number DE93016029. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report details activities of the Works Technical Department for the month of July 1954.

6693 (DUN–5558-RD) **Fuel failure reports, 1968–1969.** Newell, L.J. Douglas United Nuclear, Inc., Richland, WA (United States). 1 Mar 1969. 62p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003748. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report provides slug rupture or stuck charge documentation for 1968 and 1969.

6694 (HW–3-1835) **[Hanford 100 Area Technical Department monthly activity report], February 1945.** Worthington, H. Hanford Works, Richland, WA (United States). 2 Mar 1945. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003506. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This document details the activities of the Hanford 100 Area for the month of February 1945.

6695 (NUREG/CP–0134, pp. 35-41) **Aging, maintenance and modernization of instrumentation at the ORNL High Flux Isotope Reactor.** Fry, D.N. (Oak Ridge National Lab., TN (United States)). Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

This paper describes actions taken at ORNL to upgrade and modernize systems associated with the High Flux Isotope Reactor (HFIR). Three systems are described. The first is a redesigned resistance temperature device commonly used as a temperature detector at HFIR. The aging of existing devices, and lack of spare devices prompted the redesign of new temperature sensors which used commercial grade sensors in a redesigned assembly which allows easier maintenance. The second is a newly designed neutron detector system to replace existing aging devices. The new design uses commercial ionization chambers, in a cheaper, simpler, and less complicated design which could fit in the previous space, and provide monitoring for control and for protection. The third is the development and implementation of a new test procedure for checking the safety performance of the magnetic safety rod release system. This new procedure allows for electronic testing of the modules with considerably lessened chances that a rod will be dropped during the weekly testing.

6696 (NUREG/CP–0134, pp. 349-362) **Life extension activities and modernization strategies for instrumentation & control systems of research and power reactors in India.** Chaganty, S.P. (Bhabha Atomic Research Centre, Trombay (India)); Bairi, B.R. Nuclear Regulatory Commission, Washington, DC (United States); International Atomic Energy Agency, Vienna (Austria); Electric Power Research Inst., Palo Alto, CA (United States); Oak Ridge National Lab., TN (United States). Oct 1993. (CONF-9305215–: IAEA specialists meeting on experience in ageing, maintenance and modernization of instrumentation and control systems for improving nuclear power plant availability, Rockville, MD (United States), 5-7 May 1993). In *International Atomic Energy Agency specialists meeting on experience in ageing, maintenance, and modernization of instrumentation and control systems for improving nuclear power availability.* 577p. Source: OSTI; NTIS; INIS; GPO.

Based on three and half decades of experience gained in the operation and maintenance of Instrumentation and Control Systems of nuclear reactors in India, specific investigations were made to understand various aspects of aging. The analysis of the failure rates of various instruments, plant outage figures and obsolescence of components have necessitated the replacement of instrumentation to improve the reliability and performance. The aging models available were used to determine the extent of performance degradation and to formulate maintenance strategies. The nuclear instrumentation of the aging research reactors at Bhabha Atomic Research Centre (BARC) has been replaced with high reliability equipment using modern integrated circuits. This has resulted in an

improvement in the mean time between failure (MTBF) by a factor of five. The neutronic instrumentation of Fast Breeder Test Reactor (FBTR) at Madras is currently being upgraded with the introduction of microprocessor based safety units for reactivity computation and online testing of safety logic with Fine Impulse Technique. The operating experience has also indicated the necessity of developing online surveillance methods and status monitoring of various systems to detect aging. Online cable insulation measurement technique and noise analysis methods for vibration monitoring have been developed. Campbell method of signal processing has been successfully used in extending the useful life of Local Power Range monitors in the Boiling Water Reactor at Tarapur. In order to improve reliability, accuracy and provide efficient man machine interface, microprocessor based systems with online testing features have been installed in power reactors. These include the high performance reactor regulating system and centralised radiation monitoring systems commissioned at Kakrapara power station. The paper describes the above systems and the modernization strategies for nuclear instrumentation and control.

6697 (NUREG/CR–6117) **Neutron spectra at different High Flux Isotope Reactor (HFIR) pressure vessel surveillance locations.** Remec, I. (Josef Sefan Inst., Ljubljana (Slovenia)); Kam, F.B. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Oak Ridge National Lab., TN (United States). Dec 1993. 118p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC05-84OR21400. (ORNL/TM–12484). Source: OSTI; NTIS; INIS; GPO.

This project addresses the potential problem of radiation embrittlement of reactor pressure vessel (RPV) supports. Surveillance specimens irradiated at the High Flux Isotope Reactor (HFIR) at relatively low neutron flux levels (about 1.5E + 8 $cm^{-2}.s^{-1}$) and low temperatures (about 50°C) showed embrittlement more rapidly than expected. Commercial power reactors have similar flux levels and temperatures at the level vessel support structures. The purposes of this work are to provide the neutron fluence spectra data that are needed to evaluate previously measured mechanical property changes in the HFIR, to explain the discrepancies in neutron flux levels between the nickel dosimeters and two other dosimeters, neptunium and beryllium, and to address any questions or peculiarities of the HFIR reactor environment. The current work consists of neutron and gamma transport calculations, dosimetry measurements, and least-squares logarithmic adjustment to obtain the best estimates for the neutron spectra and the related neutron exposure parameters. The results indicate that the fission rates in neptunium-237 (Np-237) and uranium-238 (U-238) and the helium production rates in beryllium-9 (Be-9) are dominated by photo-induced reactions. The displacements per atom rate for iron (dpa/s) from gamma rays is five times higher than the dpa/s from neutrons. The neutron fluxes in key 7, position 5 do not show any significant gradient in the surveillance capsule, but key 4 and key 2 showed differences in magnitude as well as in the shape of the spectrum. The stainless steel monitor in the V-notch of the Charpy specimens of the surveillance capsules is adequate to determine the neutron flux above 1.0 MeV at the desired V-notch location. Simultaneous adjustment of neutron and gamma fluxes with the measurements has been demonstrated and should avoid future problems with photo-induced reactions.

6698 (SR/H–664) **History of operations (1 January 1944–20 March 1945).** Matthias, F.T. Hanford Engineer Works, Richland, WA (United States). [1945]. 148p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. Order Number DE94004704. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The Operating Section of this History differs from the Design and Construction Sections in that it comprises two parts, (1) a detailed treatment of the technical considerations, process difficulties, physics principles, etc., involved in the production of plutonium and (2) a description of the administrative (as distinct from the technical) problems involved in the production of plutonium and (2) a description of the administrative (as distinct from the technical) problems involved in preparation for and operation of process facilities and of Richland Village, the securing and training of personnel, and the safeguarding of personnel and process facilities in the face of the very unusual hazards involved, while at the same time maintaining secrecy and preserving effective security demanded by the nature of the work. In many cases these problems were as important and as complex and difficult of solution as the purely process problems involved. It is the purpose of this section to describe those so-called administrative features of the operation of the Hanford Engineer Works.

6699 (WSRC-TR–93-100-5) **Savannah River Technology Center: Monthly report, May 1993.** Westinghouse Savannah River Co., Aiken, SC (United States). May 1993. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004438. Source: OSTI; NTIS; GPO Dep.

This report covers the progress and accomplishments made at the Savannah River Technology Center for the month of May 1993. Progress is reported for projects in the following areas: reactors, tritium, separations, environmental, waste management, and general. General projects are: an eight week tutorial of the Los Alamos National Laboratory developed Monte Carlo Neutron Photon (MCNP) code; development of materials and fabrication technologies for the spallation and tritium targets for the accelerator production of tritium; and a program to develop welding methods to repair stainless steel containing helium.

6700 (WSRC-TR–93-464) **Final data report: Vertical process-pipe flow characteristics experiment.** Duignan, M.R.; May, C.P.; Walker, N.M. III. Westinghouse Savannah River Co., Aiken, SC (United States). Sep 1993. 134p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004026. Source: OSTI; NTIS; GPO Dep.

A database was developed for the flow of air and water through a scaled vertical section of the cold-leg process pipe which leads to the reactor inlet plenum of the L-Area Savannah River Site (SRS) reactor. The flow in the vertical pipe was such that it ranged from turbulent two-phase conditions to water-solid conditions. Data on the flow of air through that pipe section as a function of water flow are of interest in loss-of-coolant studies and to better understand data obtained from a doppler ultrasonic flowmeter which was used on the prototypic pipe section of the L-Area reactor during the L-Area Phase I Tests of 1989 and the subsequential Phase II tests done at Wyle. The scaled vertical-pipe section was 1.21m long and had an inside diameter of 0.097 m. There was a doppler ultrasonic meter and a gamma-ray densitometer located 0.2 m and 0.4, respectively, above the bottom of the vertical section. The locations of these instruments were to match similar instrument locations of the Wyle tests and the 1989 L-Area tests. This report includes most of the data taken for the Vertical Process-Pipe phase of the Plenum-Nozzle and Cold-Leg Vertical Process-Pipe Flow Characteristics Experiments. Those data include daily reference checks, to determine proper operation of all instrumentation before the experiment was run, and the actual data themselves. Not included are the videographic data which are available for each test run. However, the visual data are referenced in the report such that a specific video tape and the location on that tape are indicated for a test run. The database is from four test modes (i.e., upflow or downflow, air-water or just water). The flow rates ranged to approximately 320 gpm (≈ 10 kgpm prototypic) for water and 100 gpm for air. The pressure was near atmospheric and the temperature 80°F.

6701 (WSRC-TR–93-522) **One-quarter scale separate effects Wyle counterpart tests.** Boucher, T.J. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Anderson, J.L.; Nash, C.A. Westinghouse Savannah River Co., Aiken, SC (United States). Oct 1993. 183p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94005138. Source: OSTI; NTIS; INIS; GPO Dep.

Two-phase air-water flow testing in a scaled vertical and horizontal section of an SRS reactor hot leg was performed as part of the Separate Effects Tests carried out at the Idaho National Engineering Lab. The section of pipe that was modeled was previously studied in full scale in the 1989 L-Area Reactor tests at SRS and also at Wyle Laboratories in California. The main goal of the testing was to examine the performance of Doppler flowmeters in air-water

flow in large pipes. Result were that the flowmeters nominally measure total flow with some additional influence from the phasic air flow rate. Flow regime transitions were found to scale well with data from full size pipes when Froude number was matched.

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Refer also to citation(s) 6596, 6599, 6616, 6629, 6637, 6641, 6657, 6666, 6667, 6668, 6679, 6701, 7502, 7505, 7902, 7917, 7918

6702 (BNL-NUREG–48967) **Analyses of reliability characteristics of emergency diesel generator population using empirical Bayes methods.** Vesely, W.E. (Science Applications International Corp., Dublin, OH (United States)); Uryas'ev, S.P.; Samanta, P.K. Brookhaven National Lab., Upton, NY (United States). [1993]. 4p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-940312–2: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE93015394. Source: OSTI; NTIS; INIS; GPO Dep.

Emergency Diesel Generators (EDGs) provide backup power to nuclear power plants in case of failure of AC buses. The reliability of EDGs is important to assure response to loss-of-offsite power accident scenarios, a dominant contributor to the plant risk. The reliable performance of EDGs has been of concern both for regulators and plant operators. In this paper the authors present an approach and results from the analysis of failure data from a large population of EDGs. They used empirical Bayes approach to obtain both the population distribution and the individual failure probabilities from EDGs failure to start and load-run data over 4 years for 194 EDGs at 63 plant units.

6703 (BNL-NUREG–48994) **Sensitivity and uncertainty analyses in aging risk-based prioritizations.** Hassan, M. (Brookhaven National Lab., Upton, NY (United States)); Uryas'ev, S.; Vesely, W.E. Brookhaven National Lab., Upton, NY (United States). [1993]. 2p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-940312–3: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE93015785. Source: OSTI; NTIS; INIS; GPO Dep.

Aging risk evaluations of nuclear power plants using Probabilistic Risk Analyses (PRAs) involve assessments of the impact of aging structures, systems, and components (SSCs) on plant core damage frequency (CDF). These assessments can be used to prioritize the aging risk contributors reflecting the relative risk potential of the SSCs. Aging prioritization are important for identification of SSCs most contributing to plant risk and can provide a systematic basis on which aging risk control and management strategies for a plant can be developed. These prioritizations are, however, subject to variabilities arising from uncertainties in data and/or from various modeling assumptions. The objective of this paper is to present an evaluation of the sensitivity of aging prioritizations of active components to uncertainties in aging risk quantifications. Approaches for robust prioritization of SSCs are also presented which are less susceptible to the uncertainties.

6704 (BNL-NUREG–49610) **Sensitivity and uncertainty analyses in aging risk-based prioritizations.** Hassan, M. (Brookhaven National Lab., Upton, NY (United States)); Uryas'ev, S.; Vesely, W.E. Brookhaven National Lab., Upton, NY (United States). [1993]. 5p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-940312–41: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94003010. Source: OSTI; NTIS; INIS; GPO Dep.

Aging risk evaluations of nuclear power plants using Probabilistic Risk Analyses (PRAs) involve assessments of the impact of aging structures, systems, and components (SSCs) on plant core damage frequency (CDF). These assessments can be used to prioritize the contributors to aging risk reflecting the relative risk potential of the SSCs. Aging prioritizations are important for identifying the SSCs contributing most to plant risk and can provide a systematic basis on which aging risk control and management strategies for a plant can be developed. However, these prioritizations are subject to variabilities arising from uncertainties in data, and/or from various modeling assumptions. The objective of this paper is to present an evaluation of the sensitivity of aging prioritizations of active components to uncertainties in aging risk quantifications. Approaches for robust prioritization of SSCs also are presented which are less susceptible to the uncertainties.

6705 (BNL-NUREG–49671) **Modeling the degradation of nuclear components.** Stock, D. (Brookhaven National Lab., Upton, NY (United States)); Samanta, P.; Vesely, W. Brookhaven National Lab., Upton, NY (United States). [1993]. 4p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-931107–22: 1993 IEEE nuclear science symposium and medical imaging conference; Institute of Electrical and Electronic Engineers (IEEE) medical imaging conference, San Francisco, CA (United States); San Francisco, CA (United States), 2-5 Nov 1993; 4 Order Number DE94003995. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes component level reliability models that use information on degradation to predict component reliability, and which have been used to evaluate different maintenance and testing policies. The models are based on continuous time Markov processes, and are a generalization of reliability models currently used in Probabilistic Risk Assessment. An explanation of the models, the model parameters, and an example of how these models can be used to evaluate maintenance policies are discussed.

6706 (BNL-NUREG–49711) **Understanding aging in containment cooling systems.** Lofaro, R.J. Brookhaven National Lab., Upton, NY (United States). [1993]. 19p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-931079–14: Water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). Order Number DE94004345. Source: OSTI; NTIS; INIS; GPO Dep.

A study has been performed to assess the effects of aging in nuclear power plant containment cooling systems. Failure records from national databases, as well as plant specific data were reviewed and analyzed to identify aging characteristics for this system. The predominant aging mechanisms were determined, along with the most frequently failed components and their associated failure modes. This paper discusses the aging mechanisms present in the containment spray system and the containment fan cooler system, which are two systems used to provide the containment cooling function. The failure modes, along with the relative frequency of each is also discussed.

6707 (CONF-931079–10) **BWR control blade/channel box interaction models for SCDAP/RELAP5.** Griffin, F.P. Oak Ridge National Lab., TN (United States). [1993]. 41p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC05-84OR21400. From Water reactor safety information meeting; Bethesda, MD (United States); 25-27 Oct 1993. Order Number DE94003583. Source: OSTI; NTIS; INIS; GPO Dep.

The core of a boiling water reactor (BWR) consists of an array of fuel assemblies with cross-shaped control blades located between these assemblies. Each fuel assembly consists of a fuel rod bundle surrounded by a Zircaloy channel box. Each control blade consists of small stainless steel absorber tubes filled with B_4C powder surrounded by a stainless steel blade sheath. Under severe accident conditions, material interactions between the B_4C, stainless steel, and Zircaloy would have a significant impact on the melting and subsequent relocation of the control blade and channel box structures. This paper describes a new BWR control blade/channel box model for the SCDAP/RELAP5 severe accident analysis code that includes the effects of these material interactions. The phenomena represented by this model and the modeling techniques are derived from ORNL analyses of the BWR severe fuel damage experiments. Two examples of the operation of this new model within SCDAP/RELAP5 are provided.

6708 (CONF-940312–34) **Examples of the use of PRA in the design process and to support modifications.** Johnson,

D.H. (PLG, Inc., Newport Beach, CA (United States)); Bley, D.C.; Lin, J.C.; Schueller, J.; van Otterloo, R.W.; Ramsey, C.T.; Linn, M.A. Oak Ridge National Lab., TN (United States). 7 Sep 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 2. Probabilistic safety assessment and management conference (PSAM); San Diego, CA (United States); 20-24 Mar 1994. Order Number DE94002454. Source: OSTI; NTIS; INIS; GPO Dep.

Many, if not most, of the world's commercial nuclear power plants have been the subject of plant-specific probabilistic safety assessments (PSAs). A growing number of other nuclear facilities as well as other types of industrial installations have been the focus of plant-specific PSAs. Such studies have provided valuable information concerning the nature of the fisk of the individual facility and have been utilized to identify opportunities to manage that risk. This paper explores the risk management activities associated with three diverse facilities to demonstrate the versatility of the use of PSA to support risk related decision making. The three facilities considered are a DOE research reactor with an extensive operating history, a proposed DOE research reactor in the advanced conceptual design phase and an offshore unmanned oil and gas installation.

6709 (DOE/FTR–93017868) **Travel to Vienna, Austria for meeting on the safety of VVER 440/230 NPPs: Foreign trip report, December 9–13, 1991.** Chipman, G.L. Jr. EG and G Idaho, Inc., Idaho Falls, ID (United States). 5 Feb 1992. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE93017868. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report provides a summary of the sixth meeting of the Steering Committee of the IAEA Programme on the Safety of VVER 440/230 Nuclear Power Plants (NPPs) met the week of December 9, 1991 in Vienna Austria. The purpose of the meeting was to review the project results for phase I including the ranking and conceptual recommendations, and to develop a recommended strategy for implementation of short term, medium, and long term measures to improve operational safety.

6710 (DOE/FTR–93018258) **Travel to Cadarache, France to review the preliminary transient code input data for the Fast Flux Test Facility: Foreign trip report, July 14–21, 1991.** Harris, R.A.; Padilla, A.; Shen, P.K. Westinghouse Hanford Co., Richland, WA (United States). 12 Aug 1991. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE93018258. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The US Department of Energy (DOE) has supported collaborative arrangements that would best serve the varied needs of multi-national users of the Fast Flux Test Facility. The passive safety international program at FFTF was designed to demonstrate the safety margins in large LMR systems and to begin the difficult process of separating the relevant reactivity feedback mechanisms. An international working group on Passive Safety Testing was formed in May 1991, at the conclusion of the FFTF Internationalization Symposium sponsored by DOE and the State of Washington in Pasco, Washington. This report details a follow-up working group meeting to review the preliminary FFTF plant data for transient analysis modeling was held in Cadarache, July 17–20, 1991.

6711 (DOE/FTR–93018612) **Travel to Germany to examine equipment from the SNR-300 plant: Foreign trip report, August 5–17, 1991.** Swaim, D.J.; Guttenberg, S.; Waldo, J.B.; Burke, T.M. Westinghouse Hanford Co., Richland, WA (United States). [1991]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE93018612. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report details a technical team visit to major European Liquid Metal Reactor (LMR) sites to exchange operating information and to evaluate the use of available spare SNR-300 equipment in the US. Operating experience relating to sodium chemistry, reactivity transients and decommissioning/sodium cleaning was exchanged at Super Phenix, Phenix and Cadarache (RAPSODIE). At the SNR-300 plant equipment and storage conditions were examined and technical discussions were held relating to the utilization of major components in FFTF.

6712 (DOE/FTR–94002475) **Travel to Lithuania and Romania to discuss emergency response plans for reactor accidents: Foreign trip report, July 16–31, 1993.** Ricks, R.C. Oak Ridge Associated Universities, Inc., TN (United States). [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE94002475. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report discusses travel to attend formal discussions with the Lithuania and Romania emergency response community for purpose of assisting in establishing emergency response plans for reactor and other related accidents.

6713 (DOE/SF/16564–T4-Vol.1) **System 80+™ Standard Design: CESSAR design certification: Volume 1: Amendment I.** Combustion Engineering, Inc., Windsor, CT (United States). 21 Dec 1990. 259p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-86SF16564. Order Number DE94005054. Source: OSTI; NTIS; INIS; GPO Dep.

This report, entitled Combustion Engineering Standard Safety Analysis Report - Design Certification (CESSAR-DC), has been prepared in support of the industry effort to standardize nuclear plant designs. These Volumes, describe the Combustion Engineering, Inc. System 80+™ Standard Design. This document, Volume 1, provides an introduction and general description of plant and site envelope characteristics.

6714 (DOE/SF/16564–T4-Vol.2) **System 80+™ Standard Design: CESSAR design certification: Volume 2: Amendment I.** Combustion Engineering, Inc., Windsor, CT (United States). 21 Dec 1990. 397p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-86SF16564. Order Number DE94005055. Source: OSTI; NTIS; INIS; GPO Dep.

This report, entitled Combustion Engineering Standard Safety Analysis Report - Design Certification (CESSAR-DC), has been prepared in support of the industry effort to standardize nuclear plant designs. These documents describe the Combustion Engineering, Inc. System 80+™ Standard Design. This report, Volume 2, in conjunction with Volume 3, provides the design of structures, components, equipment and systems.

6715 (DOE/SF/16564–T4-Vol.3) **System 80+™ Standard Design: CESSAR design certification: Volume 3: Amendment I.** Combustion Engineering, Inc., Windsor, CT (United States). 21 Dec 1990. 221p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-86SF16564. Order Number DE94005056. Source: OSTI; NTIS; INIS; GPO Dep.

This report, entitled Combustion Engineering Standard Safety Analysis Report - Design Certification (CESSAR-DC), has been prepared in support of the industry effort to standardize nuclear plant designs. These documents describe the Combustion Engineering, Inc. System 80+™ Standard Design. This report, Volume 3, in conjunction with Volume 2, provides the design of structures, components, equipment and systems.

6716 (DOE/SF/16564–T4-Vol.4) **System 80+™ Standard Design: CESSAR design certification: Volume 4: Amendment I.** Combustion Engineering, Inc., Windsor, CT (United States). 21 Dec 1990. 380p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-86SF16564. Order Number DE94005057. Source: OSTI; NTIS; INIS; GPO Dep.

This report, entitled Combustion Engineering Standard Safety Analysis Report - Design Certification (CESSAR-DC), has been prepared in support of the industry effort to standardize nuclear plant designs. These documents describe the Combustion Engineering, Inc. System 80+™ Standard Design. This report, Volume 4, provides a description of the reactor, reactor internals, fuel assemblies, and associated design requirements.

6717 (DOE/SF/16564–T4-Vol.6) **System 80+™ Standard Design: CESSAR design certification: Volume 6: Amendment I.** Combustion Engineering, Inc., Windsor, CT (United States). 21 Dec 1990. 450p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-86SF16564. Order Number DE94005059. Source: OSTI; NTIS; INIS; GPO Dep.

This report, entitled Combustion Engineering Standard Safety Analysis Report - Design Certification (CESSAR-DC), has been

prepared in support of the industry effort to standardize nuclear plant designs. These documents describe the Combustion Engineering, Inc. System 80+™ Standard Design. This report, Volume 6, in conjunction with Volume 7, provides a description of engineered safety features.

6718 (DOE/SF/16564–T4-Vol.7) **System 80+™ Standard Design: CESSAR design certification: Volume 7: Amendment I.** Combustion Engineering, Inc., Windsor, CT (United States). 21 Dec 1990. 276p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-86SF16564. Order Number DE94005060. Source: OSTI; NTIS; INIS; GPO Dep.

This report, entitled Combustion Engineering Standard Safety Analysis Report - Design Certification (CESSAR-DC), has been prepared in support of the industry effort to standardize nuclear plant designs. These documents describe the Combustion Engineering, Inc. System 80+™ Standard Design. This report, Volume 7, in conjunction with Volume 6, provides a description of engineered safety features.

6719 (DOE-STD–0101T) **TAP 1: Training Program Manual.** USDOE, Washington, DC (United States). Aug 1993. 39p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003651. Source: OSTI; NTIS; INIS; GPO Dep.

Superseding DOE/NE-0101T.

The Training Accreditation Program (TAP) was established by the Department of Energy (DOE) to assist in achieving excellence in the development and implementation of performance-based nuclear facility training programs. The TAP establishes the objectives and criteria against which DOE nuclear facility training is evaluated for accreditation. The TAP Staff provides assistance to contractors, develops training guidelines, and evaluates the quality and effectiveness of facility training. This manual describes the accreditation process, provides functional descriptions for positions which require accredited training programs, provides a brief discussion of performance-based training, contains the objectives and criteria that must be addressed in training programs subject to accreditation, and includes a glossary.

6720 (IKE–4-136) **The European source term code ESTER - basic ideas and tools for coupling of ATHLET and ESTER: Final report. Preparing the coupling of ATHLET and ESTER.** Schmidt, F.; Schuch, A.; Hinkelmann, M. Stuttgart Univ. (Germany). Inst. fuer Kernenergetik und Energiesysteme. Apr 1993. 66p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 1500945. Order Number DE94734092. Source: OSTI; NTIS (US Sales Only); INIS.

The French software house CISI and IKE of the University of Stuttgart have developed during 1990 and 1991 in the frame of the Shared Cost Action Reactor Safety the informatic structure of the European Source TERm Evaluation System (ESTER). Due to this work tools became available which allow to unify on an European basis both code development and code application in the area of severe core accident research. The behaviour of reactor cores is determined by thermal hydraulic conditions. Therefore for the development of ESTER it was important to investigate how to integrate thermal hydraulic code systems with ESTER applications. This report describes the basic ideas of ESTER and improvements of ESTER tools in view of a possible coupling of the thermal hydraulic code system ATHLET and ESTER. Due to the work performed during this project the ESTER tools became the most modern informatic tools presently available in the area of severe accident research. A sample application is given which demonstrates the use of the new tools. (orig.)

6721 (LA-SUB–93-131) **Cavitation and two-phase flow characteristics of SRPR (Savannah River Plant Reactor) pump: Final report.** Los Alamos National Lab., NM (United States); OF Technologies, Inc., Pasadena, CA (United States). Jul 1991. 219p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94002569. Source: OSTI; NTIS; GPO Dep.

The possible head degradation of the SRPR pumps may be attributable to two independent phenomena, one due to the inception of cavitation and the other due to the two-phase flow phenomena. The head degradation due to the appearance of cavitation on the pump blade is hardly likely in the conventional pressurized water reactor (PWR) since the coolant circulating line is highly pressurized so that the cavitation is difficult to occur even at LOCA (loss of coolant accident) conditions. On the other hand, the suction pressure of SRPR pump is order-of-magnitude smaller than that of PWR so that the cavitation phenomena, may prevail, should LOCA occur, depending on the extent of LOCA condition. In this study, therefore, both cavitation phenomena and two-phase flow phenomena were investigated for the SRPR pump by using various analytical tools and the numerical results are presented herein.

6722 (LA-UR–93-3667) **Survey and evaluation of aging risk assessment methods and applications.** Sanzo, D.L. (Los Alamos National Lab., NM (United States)); Kvam, P.; Apostolakis, G.; Wu, J.; Milici, T.; Ghoniem, N.; Guarro, S. Los Alamos National Lab., NM (United States). [1993]. 9p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–36: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94002721. Source: OSTI; NTIS; INIS; GPO Dep.

The Nuclear Regulatory Commission (NRC) initiated the nuclear power plant aging research (NPAR) program about 6 years ago to gather information about nuclear power plant aging. Since then, this program has collected a significant amount of information, largely qualitative, on plant aging and its potential effects on plant safety. However, this body of knowledge has not yet been integrated into formalisms that can be used effectively and systematically to assess plant risk resulting from aging, although models for assessing the effect of increasing failure rates on core damage frequency have been proposed. The purpose of this review is to survey the work conducted to address the aging of systems, structures, and components (SSCs) of nuclear power plants (NPPs), as well as the associated data bases. The review takes a critical look at the need to revise probabilistic risk assessment (PRAs) so that they will include the contribution to risk from plant aging, the adequacy of existing methods for evaluating this contribution, and the adequacy of the data that have been used in these evaluation methods. A preliminary framework is identified for integrating the aging of SSCs into the PRA, including the identification of needed data for such an integration.

6723 (NUREG–0750-Vol.38-No.4) **Nuclear Regulatory Commission issuances, October 1993: Volume 38, No. 4.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Oct 1993. 22p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This document contains a Commission issuance in which the Commission denies the petitioners' motion to quash or modify a subpoena issued by the NRC staff in the course of an investigation to determine if the petitioners' have violated NRC regulations and to determine if safety-related problems exist at NRC-licensed facilities. The pertinent regulations and the Commission's Memorandum and Order are included.

6724 (NUREG/CR–4832-Vol.8) **Analysis of the LaSalle Unit 2 nuclear power plant: Risk Methods Integration and Evaluation Program (RMIEP): Volume 8, Seismic analysis.** Wells, J.E. (Lawrence Livermore National Lab., CA (United States)); Lappa, D.A.; Bernreuter, D.L.; Chen, J.C.; Chuang, T.Y.; Johnson, J.J.; Campbell, R.D.; Hashimoto, P.S.; Maslenikov, O.R.; Tiong, L.W.; Ravindra, M.K.; Kincaid, R.H.; Sues, R.H.; Putcha, CNuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Lawrence Livermore National Lab., CA (United States); EQE International, Inc., Irvine, CA (United States); NTS Engineering, Long Beach, CA (United States). Nov 1993. 287p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-48. (UCID–21245-Vol.8). Source: OSTI; NTIS; INIS; GPO.

This report describes the methodology used and the results obtained from the application of a simplified seismic risk methodology to the LaSalle County Nuclear Generating Station Unit 2. This study is part of the Level I analysis being performed by the Risk Methods Integration and Evaluation Program (RMIEP). Using the

RMIEP developed event and fault trees, the analysis resulted in a seismically induced core damage frequency point estimate of 6.OE-7/yr. This result, combined with the component importance analysis, indicated that system failures were dominated by random events. The dominant components included diesel generator failures (failure to swing, failure to start, failure to run after started), and condensate storage tank.

6725 (NUREG/CR–5360) **XSOR codes users manual.** Jow, Hong-Nian (Sandia National Labs., Albuquerque, NM (United States)); Murfin, W.B.; Johnson, J.D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Sandia National Labs., Albuquerque, NM (United States); Technadyne Engineering Consultants, Inc., Albuquerque, NM (United States); Science Applications International Corp., Albuquerque, NM (United States). Nov 1993. 306p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (SAND–89-0943). Source: OSTI; NTIS; INIS; GPO.

This report describes the source term estimation codes, XSORs. The codes are written for three pressurized water reactors (Surry, Sequoyah, and Zion) and two boiling water reactors (Peach Bottom and Grand Gulf). The ensemble of codes has been named "XSOR". The purpose of XSOR codes is to estimate the source terms which would be released to the atmosphere in severe accidents. A source term includes the release fractions of several radionuclide groups, the timing and duration of releases, the rates of energy release, and the elevation of releases. The codes have been developed by Sandia National Laboratories for the US Nuclear Regulatory Commission (NRC) in support of the NUREG-1150 program. The XSOR codes are fast running parametric codes and are used as surrogates for detailed mechanistic codes. The XSOR codes also provide the capability to explore the phenomena and their uncertainty which are not currently modeled by the mechanistic codes. The uncertainty distributions of input parameters may be used by an XSOR code to estimate the uncertainty of source terms.

6726 (NUREG/CR–5901-Final) **A simplified model of aerosol scrubbing by a water pool overlying core debris interacting with concrete: Final report.** Powers, D.A. (Sandia National Labs., Albuquerque, NM (United States)); Sprung, J.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Sandia National Labs., Albuquerque, NM (United States). Nov 1993. 116p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (SAND–92-1422-Final). Source: OSTI; NTIS; INIS.

A classic model of aerosol scrubbing from bubbles rising through water is applied to the decontamination of gases produced during core debris interactions with concrete. The model, originally developed by Fuchs, describes aerosol capture by diffusion, sedimentation, and inertial impaction. This original model for spherical bubbles is modified to account for ellipsoidal distortion of the bubbles. Eighteen uncertain variables are identified in the application of the model to the decontamination of aerosols produced during core debris interactions with concrete by a water pool of specified depth and subcooling. These uncertain variables include properties of the aerosols, the bubbles, the water and the ambient pressure. Results are analyzed using a nonparametric, order statistical analysis that allows quantitative differentiation of stochastic and phenomenological uncertainty. The sampled values of the decontamination factors are used to construct estimated probability density functions for the decontamination factor at confidence levels of 50%, 90% and 95%. The decontamination factors for pools 30, 50, 100, 200, 300, and 500 cm deep and subcooling levels of 0, 2, 5, 10, 20, 30, 50, and 70°C are correlated by simple polynomial regression. These polynomial equations can be used to estimate decontamination factors at prescribed confidence levels.

6727 (NUREG/CR–5907) **Core-concrete interactions with overlying water pools: The WETCOR-1 test.** Blose, R.E. (Ktech Corp., Albuquerque, NM (United States)); Powers, D.A.; Copus, E.R.; Brockmann, J.E.; Simpson, R.B.; Lucero, D.A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (United States); Ktech Corp., Albuquerque, NM (United States). Nov 1993. 168p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-76DP00789. (SAND–92-1563). Source: OSTI; NTIS; INIS; GPO.

The WETCOR-1 test of simultaneous interactions of a high-temperature melt with water and a limestone/common-sand concrete is described. The test used a 34.1-kg melt of 76.8 w/o Al_2O_3, 16.9 w/o CaO, and 4.0 w/o SiO_2 heated by induction using tungsten susceptors. Once quasi-steady attack on concrete by the melt was established, an attempt was made to quench the melt at 1850 K with 295 K water flowing at 57 liters per minute. Net power into the melt at the time of water addition was 0.61 $\pm$ 0.19 W/cm^3. The test configuration used in the WETCOR-1 test was designed to delay melt freezing to the walls of the test fixture. This was done to test hypotheses concerning the inherent stability of crust formation when high-temperature melts are exposed to water. No instability in crust formation was observed. The flux of heat through the crust to the water pool maintained over the melt in the test was found to be 0.52 $\pm$ 0.13 MW/m^2. Solidified crusts were found to attenuate aerosol emissions during the melt concrete interactions by factors of 1.3 to 3.5. The combination of a solidified crust and a 30-cm deep subcooled water pool was found to attenuate aerosol emissions by factors of 3 to 15.

6728 (NUREG/CR–5949) **Assessment of the potential for high-pressure melt ejection resulting from a Surry station blackout transient.** Knudson, D.L. (EG and G Idaho, Inc., Idaho Falls, ID (United States)); Dobbe, C.A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; EG and G Idaho, Inc., Idaho Falls, ID (United States). Nov 1993. 172p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC07-76ID01570. (EGG–2689). Source: OSTI; NTIS; INIS; GPO.

Containment integrity could be challenged by direct heating associated with a high pressure melt ejection (HPME) of core materials following reactor vessel breach during certain severe accidents. Intentional reactor coolant system (RCS) depressurization, where operators latch pressurizer relief valves open, has been proposed as an accident management strategy to reduce risks by mitigating the severity of HPME. However, decay heat levels, valve capacities, and other plant-specific characteristics determine whether the required operator action will be effective. Without operator action, natural circulation flows could heat ex-vessel RCS pressure boundaries (surge line and hot leg piping, steam generator tubes, etc.) to the point of failure before vessel breach, providing an alternate mechanism for RCS depressurization and HPME mitigation. This report contains an assessment of the potential for HPME during a Surry station blackout transient without operator action and without recovery. The assessment included a detailed transient analysis using the SCDAP/RELAP5/MOD3 computer code to calculate the plant response with and without hot leg countercurrent natural circulation, with and without reactor coolant pump seal leakage, and with variations on selected core damage progression parameters. RCS depressurization-related probabilities were also evaluated, primarily based on the code results.

6729 (NUREG/CR–5995) **Technical Specification action statements requiring shutdown: A risk perspective with application to the RHR/SSW systems of a BWR.** Mankamo, T. (Avaplan Oy, Espoo (Finland)); Kim, I.S.; Samanta, P.K. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; Avaplan Oy, Espoo (Finland); Brookhaven National Lab., Upton, NY (United States). Nov 1993. 171p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (BNL-NUREG–52364). Source: OSTI; NTIS; INIS; GPO.

When safety systems fail during power operation, the limiting conditions for operation (LCOs) and associated action statements of technical specifications typically require that the plant be shut down within the limits of allowed outage time (AOT). However, when a system needed to remove decay heat, such as the residual heat removal (RHR) system, is inoperable or degraded, shutting down the plant may not necessarily be preferable, from a risk perspective, to continuing power operation over a usual repair time, giving priority to the repairs. The risk impact of the basic operational alternatives, i.e., continued operation or shutdown, was evaluated

for failures in the RHR and standby service water (SSW) systems of a boiling-water reactor (BWR) nuclear power plant. A complete or partial failure of the SSW system fails or degrades not only the RHR system but other front-line safety systems supported by the SSW system. This report presents the methodology to evaluate the risk impact of LCOs and associated AOT; the results of risk evaluation from its application to the RHR and SSW systems of a BWR; the findings from the risk-sensitivity analyses to identify alternative operational policies; and the major insights and recommendations to improve the technical specifications action statements.

6730 (NUREG/CR–6025) **The probability of Mark-I containment failure by melt-attack of the liner.** Theofanous, T.G. (California Univ., Santa Barbara, CA (United States). Dept. of Chemical and Nuclear Engineering); Yan, H.; Podowski, M.Z. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; California Univ., Santa Barbara, CA (United States). Dept. of Chemical and Nuclear Engineering; Rensselaer Polytechnic Inst., Troy, NY (United States). Dept. of Nuclear Engineering and Engineering Physics; Sandia National Labs., Albuquerque, NM (United States); Argonne National Lab., IL (United States); ANATECH Research Corp., San Diego, CA (United States). Nov 1993. 361p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-31109-ENG-38 ; AC04-94AL85000. (SAND–93-0893; SAND–93-0925; ANA–92-0143; ANL/RE/LWR–92-5). Source: OSTI; NTIS; INIS.

This report is a followup to the work presented in NUREG/CR-5423 addressing early failure of a BWR Mark I containment by melt attack of the liner, and it constitutes a part of the implementation of the Risk-Oriented Accident Analysis Methodology (ROAAM) employed therein. In particular, it expands the quantification to include four independent evaluations carried out at Rensselaer Polytechnic Institute, Argonne National Laboratories, Sandia National Laboratories and ANATECH, Inc. on the various portions of the phenomenology involved. These independent evaluations are included here as Parts II through V. The results, and their integration in Part I, demonstrate the substantial synergism and convergence necessary to recognize that the issue has been resolved.

6731 (NUREG/CR–6101) **Software reliability and safety in nuclear reactor protection systems.** Lawrence, J.D. (Lawrence Livermore National Lab., CA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Reactor Controls and Human Factors; Lawrence Livermore National Lab., CA (United States). Nov 1993. 139p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-48. (UCRL-ID–114839). Source: OSTI; NTIS; INIS; GPO.

Planning the development, use and regulation of computer systems in nuclear reactor protection systems in such a way as to enhance reliability and safety is a complex issue. This report is one of a series of reports from the Computer Safety and Reliability Group, Lawrence Livermore that investigates different aspects of computer software in reactor National Laboratory, that investigates different aspects of computer software in reactor protection systems. There are two central themes in the report, First, software considerations cannot be fully understood in isolation from computer hardware and application considerations. Second, the process of engineering reliability and safety into a computer system requires activities to be carried out throughout the software life cycle. The report discusses the many activities that can be carried out during the software life cycle to improve the safety and reliability of the resulting product. The viewpoint is primarily that of the assessor, or auditor.

6732 (NUREG/IA–0110) **Assessment of RELAP5/MOD2 against a main feedwater turbopump trip transient in the Vandellos II Nuclear Power Plant.** Llopis, C. (Asociacion Nuclear Vandellos, Madrid (Spain)); Casals, A.; Perez, J.; Mendizabal, R. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Asociacion Nuclear de Vandellos, Madrid (Spain); Consejo de Seguridad Nuclear, Madrid (Spain). Dec 1993. 49p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). (ICSP–V2-TURFW-R). Source: OSTI; NTIS; INIS; GPO.

The Consejo de Seguridad Nuclear (CSN) and the Asociacion Nuclear Vandellos (ANV) have developed a model of Vandellos II Nuclear Power Plant. The ANV collaboration consisted in the supply of design and actual data, the cooperation in the simulation of the control systems and other model components, as well as in the results analysis. The obtained model has been assessed against the following transients occurred in plant: A trip from the 100% power level (CSN); a load rejection from 100% to 50% (CSN); a load rejection from 75% to 65% (ANV); and, a feedwater turbopump trip (ANV). This copy is a report of the feedwater turbopump trip transient simulation. This transient actually occurred in the plant on June 19, 1989.

6733 (SAND–93-1203C) **Coherent sampling of multiple branch event tree questions.** Payne, A.C. Jr.; Wyss, G.D. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–19: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001603. Source: OSTI; NTIS; GPO Dep.

In the detailed phenomenological event trees used in recent Level III PRA analyses questions arise about the possible outcomes of events for which the underlying physics is not well understood and where the initial and boundary conditions are uncertain. Examples of the types of events being analyzed are: What is the containment failure mode?, Is them a large in-vessel steam explosion?, How much H_2, CO, and CO_2 are produced during core-concrete interactions? The outcomes of each of these questions must be defined based on an understanding of the basic physics of the phenomena and the level of detail of the probabilistic analysis. Many of these phenomena have never occurred since severe reactor accidents are extremely rare events. The only information we have about these phenomena comes from four basic sources: general theoretical knowledge, limited experimental results a few actual events, and various models of the phenomena. All of these phenomena have significant uncertainty arising from three basic sources: level of detail, initial and boundary conditions, and lack of knowledge. Since it is not possible to conduct enough full scale tests to generate a set of "objective" relative frequencies, the probabilities, therefore, will have to be "subjective" and generated based on expert knowledge. In assessing the conditional probabilities of the various possible outcomes of an event during an accident, the expert must amalgamate his knowledge with the level of detail being used in the PRA analysis to generate a set of probabilities for the defined set of outcomes. It is often convenient for an expert to formulate his opinion in terms of expecting to see n_i occurrences of outcome E_i in N occurrences of event E. The order of the outcomes is typically not important because the individual trials are viewed as being independent of one another.

6734 (SAND–93-1253C) **Results and insights from the low power and shutdown Level 1 PRA of the Grand Gulf Nuclear Power Station.** Whitehead, D.W. (Sandia National Labs., Albuquerque, NM (United States)); Staple, B.D.; Daniel, S.L.; Darby, J.; Miller, S.; Forester, J.; Yakle, J. Sandia National Labs., Albuquerque, NM (United States). 1993. 6p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–43: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94003232. Source: OSTI; NTIS; INIS; GPO Dep.

The US Nuclear Regulatory Commission's Office of Nuclear Regulatory Research has undertaken a two-phase project to analyze the frequencies, consequences, and risk of accidents occurring during modes of operation other than full power (i.e., low power and shutdown (LP&S) conditions). The Phase 1 work represented a "coarse screening" of all identified modes of operation. The results were used to identify which set of plant operating conditions would be subjected to a detailed analysis during Phase 2. This paper presents an overview of the results from the current Phase 2 effort to identify and quantify the various accident sequences that can lead to severe core damage. This overview encompasses the detailed analysis of potential accidents that could occur at the

Grand Gulf Nuclear Power Plant while in the Cold Shutdown Phase [Plant Operational State (POS) 5] of a refueling outage.

6735 (SAND–93-1321C) **Analysis of extreme top event frequency percentiles based on fast probability integration.** Staple, B. (Sandia National Labs., Albuquerque, NM (United States)); Haskin, F.E. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–16: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001544. Source: OSTI; NTIS; INIS; GPO Dep.

In risk assessments, a primary objective is to determine the frequency with which a collection of initiating and basic events, E_e leads to some undesired top event, T. Uncertainties in the occurrence rates, x_t, assigned to the initiating and basic events cause uncertainty in the top event frequency, z_T. The quantification of the uncertainty in z_T is an essential part of risk assessment called uncertainty analysis. In the past, it has been difficult to evaluate the extreme percentiles of output variables like z_T. Analytic methods such as the method of moments do not provide estimates of output percentiles and the Monte Carlo (MC) method can be used to estimate extreme output percentiles only by resorting to large sample sizes. A promising altemative to these methods is the fast probability integration (FPI) methods. These methods approximate the integrals of multi-variate functions, representing percentiles of interest, without recourse to multi-dimensional numerical integration. FPI methods give precise results and have been demonstrated to be more efficient than MC methods for estimating extreme output percentiles. FPI allows the analyst to choose extreme percentiles of interest and perform sensitivity analyses in those regions. Such analyses can provide valuable insights as to the events driving the top event frequency response in extreme probability regions. In this paper, FPI methods are adapted a) to precisely estimate extreme top event frequency percentiles and b) to allow the quantification of sensitivity measures at these extreme percentiles. In addition, the relative precision and efficiency of alternative methods for treating lognormally distributed inputs is investigated. The methodology is applied to the top event frequency expression for the dominant accident sequence from a risk assessment of Grand Gulf nuclear power plant.

6736 (SAND–93-1377) **MELCOR 1.8.2 assessment: The DF-4 BWR Damaged Fuel experiment.** Tautges, T.J. Sandia National Labs., Albuquerque, NM (United States). Oct 1993. 225p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94004681. Source: OSTI; NTIS; INIS; GPO Dep.

MELCOR is a fully integrated, engineering-level computer code being developed at Sandia National Laboratories for the USNRC, that models the entire spectrum of severe accident phenomena in a unified framework for both BWRs and PWRs. As a part of an ongoing assessment, program, MELCOR has been used to model the ACRR in-pile DF-4 Damaged Fuel experiment. DF-4 provided data for early phase melt progression in BWR fuel assemblies, particularly for phenomena associated with eutectic interactions in the BWR control blade and zircaloy oxidation in the canister and cladding. MELCOR provided good agreement with experimental data in the key areas of eutectic material behavior and canister and cladding oxidation. Several shortcomings associated with the MELCOR modeling of BWR geometries were found and corrected. Twenty-five sensitivity studies were performed on COR, HS and CVH parameters. These studies showed that the new MELCOR eutectics model played an important role in predicting control blade behavior. These studies revealed slight time step dependence and no machine dependencies. Comparisons made with the results from four best-estimate codes showed that MELCOR did as well as these codes in matching DF-4 experimental data.

6737 (SAND–93-1475) **MELCOR 1.8.2 Assessment: IET direct containment heating tests.** Kmetyk, L.N. Sandia National Labs., Albuquerque, NM (United States). Oct 1993. 202p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94004679. Source: OSTI; NTIS; INIS; GPO Dep.

MELCOR is a fully integrated, engineering-level computer code, being developed at Sandia National Laboratories for the USNRC, that models the entire spectrum of severe accident phenomena in a unified framework for both BWRs and PWRS. As part of an ongoing assessment program, the MELCOR computer code has been used to analyze several of the IET direct containment heating experiments done at 1:10 linear scale in the Surtsey test facility at Sandia and at 1:40 linear scale in the corium-water thermal interactions (CWTI) COREXIT test facility at Argonne National Laboratory. These MELCOR calculations were done as an open post-test study, with both the experimental data and CONTAIN results available to guide the selection of code input. Basecase MELCOR results are compared to test data in order to evaluate the new HPME DCH model recently added in MELCOR version 1.8.2. The effect of various user-input parameters in the HPME model, which define both the initial debris source and the subsequent debris interaction, were investigated in sensitivity studies. In addition, several other non-default input modelling changes involving other MELCOR code packages were required in our IET assessment analyses in order to reproduce the observed experiment behavior. Several calculations were done to identify whether any numeric effects exist in our DCH IET assessment analyses.

6738 (SAND–93-1498C) **MELCOR technical assessment at SNL.** Kmetyk, L.N.; Tautges, T.J. Sandia National Labs., Albuquerque, NM (United States). [1993]. 25p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931079–12: Water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). Order Number DE94003712. Source: OSTI; NTIS; INIS; GPO Dep.

MELCOR is a fully integrated, engineering-level computer code that models the progression of severe accidents in light water reactor (LWR) nuclear power plants, which is being developed at Sandia National Laboratories for the US Nuclear Regulatory Commission (US-NRC). The entire spectrum of severe accident phenomena, including reactor coolant system and containment thermal/hydraulic response, core heatup, degradation and relocation, and fission product release and transport, is treated in MELCOR in a unified framework for both boiling water reactors (PRWs). The MELCOR computer code has been developed to the point that is now being successfully applied in severe accident analyses, particularly in probabilistic risk assessment (PRA) studies. MELCOR was the first of the severe accident analysis code to undergo a formal peer review process. One of the major conclusions of the recent MELCOR Peer Review was the need for a more comprehensive and more systematic program of MELCOR assessment. This report provides a discussion of this technical assessment.

6739 (SAND–93-2218C) **Generic event trees and the treatment of dependencies and non-proceduralized actions in a low power and shutdown Probabilistic Risk Assessment.** Forester, J. (Science Applications International Corp., Albuquerque, NM (United States)); Yakle, J.; Whitehead, D.; Darby, J. Sandia National Labs., Albuquerque, NM (United States). 1993. 6p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–42: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94003233. Source: OSTI; NTIS; INIS; GPO Dep.

Sandia National Laboratories was tasked by the US Nuclear Regulatory Commission to perform a Probabilistic Risk Assessment (PRA) of a boiling water reactor (BWR) during low power and shutdown (LP&S) conditions. The plant chosen for the study was Grand Gulf Nuclear Station (GGNS), a BWR 6. In performing the analysis, it was found that in comparison with full-power PRAs, the low decay heat levels present during LP&S conditions result in a relatively large number of ways by which cooling can be provided to the core. In addition, because of the less stringent requirements imposed on system configurations possible is large and the availability of plant systems is more difficult to specify. These aspects of the LP&S environment led to the development and use of "generic" event trees in performing the analysis. The use of "generic" event trees, in turn, had a significant impact on the nature of the human reliability analysis (HRA) that was performed. This paper describes

the development of the event trees for the LP&S PRA and important aspects of the resulting HRA.

6740 (SAND–93-2297C) **Risk perspectives for TOPAZ II flight mission.** Payne, A.C. Jr. (Sandia National Labs., Albuquerque, NM (United States)); Haskin, F.E. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940101–20: 11. symposium on space nuclear power systems, Albuquerque, NM (United States), 9-13 Jan 1994). Order Number DE94003229. Source: OSTI; NTIS; GPO Dep.

The purpose of this paper is to present a preliminary estimate of the nuclear-related public health risk presented by launching and operating the Russian TOPAZ II space reactor as part of the Nuclear Electric Propulsion Space Test Program (NEPSTP). This risk is then compared to the risks from the operation of commercial nuclear power reactors and previously planned and/or launched space nuclear power missions. For the current mission profile, the initial estimate of the risk posed by launching and operating TOPAZ II is significantly less (at least two orders of magnitude) than that estimated for prior space nuclear missions. Even allowing for the large uncertainties in this estimate, it does not appear that the NEPSTP mission will present a significant health risk to the public.

6741 (SAND–93-2383C) **Summary of uncertainty analysis of dispersion and deposition modules of the MACCS and COSYMA consequence codes: A joint USNRC/CEC study.** Harper, F.T. (Sandia National Labs., Albuquerque, NM (United States)); Miller, L.A.; Young, M.L.; Goossens, L.H.J.; Cooke, R.M.; Hora, S.C.; Pasler-Sauer, J.; Lui, C.; Kelly, N. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–30: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001423. Source: OSTI; NTIS; INIS; GPO Dep.

This paper briefly describes an ongoing project designed to assess the uncertainty in offsite radiological consequence calculations of hypothetical accidents in commercial nuclear power plants. This project is supported jointly by the Commission of European Communities (CEC) and the US Nuclear Regulatory Commission (USNRC). Both commissions have expressed an interest in assessing the uncertainty in consequence calculations used for risk assessments and regulatory purposes.

6742 (SIEMENS-KWU-U9–414/88/027) **Upgrading of aerosol generators for use at Cadarache (CEA): Final report.** Kaspar, G.; Loescher, H.; Ruhmann, H. Siemens AG Unternehmensbereich KWU, Erlangen (Germany). Abt. Brennelement-Technologie. Nov 1988. 27p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 1500759. Order Number DE94734003. Source: OSTI; NTIS (US Sales Only); INIS.

The aerosol generators developed for, and used in, the DEMONA project have been further developed for the FUCHIA project run by CEA. As a result of these efforts the generators have been uprated for fifty-hour continuous generation of SnO_2 and CsOH aerosols at a rate of 10 g/min against a system pressure of 5 bar. Significantly higher feed rates may be possible but were not required. The development objective was fully satisfied, the generators are ready for service in the FUCHIA project. (orig.). 1 ref., 2 tabs., 9 figs.

6743 (UCRL-ID–115234) **Title I wind/tornado design guidelines for new production reactors.** Ng, D.S. (Lawrence Livermore National Lab., CA (United States)); Holman, G.S. Lawrence Livermore National Lab., CA (United States); Wind/Tornado Working Group (United States). Sep 1993. 107p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004686. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report documents the strategy employed to develop wind/tornado hazard design guidelines and recommended design guidelines for the new production reactors currently planned for the Idaho National Engineering Laboratory (INEL) and Savannah River (SR) sites. The criteria were developed by a Wind/Tornado Working Group (WTWG) comprised of six nationally recognized experts who are knowledgeable in the fields of structural engineering, wind engineering and meteorology. The goal of the working group is to develop a set of technically defensible guidelines and to demonstrate that these guidelines will lead to facilities that meet the HWR-RD-0001-01 and MGR-RD-0001-01 safety goals. The basic philosophy behind development of these criteria was to select realistic wind and missile load specifications and to meet the performance goals by applying conservative structural response evaluation and acceptance criteria.

6744 (WAPD-T–2966) **FLASH predictions of the MB-2 steam line break tests.** Lincoln, F.W.; Coffield, R.D.; Johnson, E.G. Westinghouse Electric Corp., West Mifflin, PA (United States). Bettis Atomic Power Lab. [1992]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-9211284–1: American Nuclear Society winter meeting, Washington, DC (United States), Nov 1992). Order Number DE94003725. Source: OSTI; NTIS; INIS; GPO Dep.

If a main steam line from a pressurized water reactor (PWR) steam generator were to rupture, the effect would be a depressurization of the secondary side and a consequential overcooling transient on the primary side. Analyses must accurately predict the effects of the rapid cooldown of the reactor vessel coolant on positive nuclear-kinetic reactivity feedback to the core plus thermal shock to the reactor vessel and other primary system components. Many early studies of the steam line break (SLB) transient made extremely conservative assumptions to maximize the primary to secondary heat transfer which in turn maximized the reactor vessel cooldown rate. Among the more significant of these assumptions was that flow from the break was pure steam and that the tube bundle remained covered until the secondary mass inventory was significantly reduced. The Model F commercial PWR steam generator testing performed in the Model Boiler No. 2 (MB-2) facility located at the Westinghouse Engineering Test Facility in Tampa, Florida provided data to better qualify the actual variation in these key parameters. A conclusion of this analysis is that the MB-2 steam line break data base is accurate and of sufficient detail to provide a valuable basis for making comparisons relative to code predictions. Results obtained using the FLASH transient safety analysis code were found to be in excellent agreement with the data.

6745 (WSRC-MS–92-475) **An SAR issue for the Savanah River reactors resolved with PRA methods.** Topp, S.V. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940312–15: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE93019833. Source: OSTI; NTIS; GPO Dep.

A Level 1 Probabilistic Risk Assessment (PRA) was completed in July, 1990, and revised and updated in January, 1993, for the Department of Energy production reactors at the Savannah River Site in Aiken, S.C. The PRA has since been used several times to guide risk management decisions, as well as to quantify absolute risk and to help in understanding system interactions. This paper describes one of the risk management applications where PRA analysis determined that a reactor subcriticality issue being considered for inclusion in the Safety Analysis Report (SAR) is low enough in expected frequency that it can be excluded.

6746 (WSRC-MS–93-084) **Performance degradation of a large production reactor recirculation pump during off-design conditions.** Whitehouse, J.C. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-9311127–1: American Society of Mechanical Engineers (ASME) Eastern regional rotating machinery conference, Somerset, NJ (United States), 9-12 Nov 1993). Order Number DE94003122. Source: OSTI; NTIS; INIS; GPO Dep.

In order to accurately predict reactor hydraulic behavior during a hypothetical Loss-of-Coolant-Accident (LOCA) the performance of reactor coolant pumps under off-design conditions must be understood. The LOCA of primary interest for the Savannah River Site

(SRS) production reactors involves the aspiration of air into the recirculated heavy water flow as reactor tank inventory is lost, (system temperatures are too low to result in significant flashing of water coolant into steam). Entrained air causes degradation in the performance of the large recirculation pumps. The amount of degradation is a parameter used in computer codes which predict the course of the accident. This paper describes the analysis of data obtained during in-reactor simulated LOCA tests, and presents the head degradation curve for the SRS reactor recirculation pumps. The greatest challenge of the analysis was to determine a reasonable estimate of mixture density at the pump suction. Specially designed three-beam densitometers were used to determine mixture density. Since it was not feasible to place them in the most advantageous location, measured pump motor power along with other techniques, were used to calculate the average mixture density at the pump impeller. This technique provides a good estimate of pump suction mixture density. Measurements from more conventional instruments were used to arrive at the value of pump two-component head over a wide range of flows. The results were significantly different from previous work with commercial reactor recirculation pumps. Further experimental work using a 1/4 scale model of the SRS pump should provide an opportunity to confirm these results, and is currently in progress.

6747 (WSRC-MS–93-353) **K Reactor restart configuration: Level 1 internal events PRA results.** Tinnes, S.P. (Westinghouse Savannah River Co., Aiken, SC (United States)); Cramer, D.S.; Logan, V.E.; Topp, S.V.; Smith, J.A.; Ford, H.A.; Bailey, R.T.; Brandyberry, M.D.; Taylor, R.P.; O'Kula, K.R.; Kingery, B.G.; Paris, L.D.; Bowen, J.R.; Rosenberg, L.B.Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940312–1: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE93013587. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report discusses a full-scope probabilistic risk assessment (PRA) has been performed for the Savannah River Site (SRS) K Reactor restart configuration prior to the initiation of lay-up activities in 1993. The Level 1 PRA includes the assessment of reactor systems response to accidents and estimates of core damage. The internal events spectrum includes those events related directly to plant systems and safety functions for which transients or failures may initiate an accident.

6748 (WSRC-TR–93-507) **Supplementary safety system 1/4 scale testing.** Garrett, R.L.; Paik, I.K. Westinghouse Savannah River Co., Aiken, SC (United States). Sep 1993. 248p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94003857. Source: OSTI; NTIS; GPO Dep.

During the course of updating the K-Reactor Safety Analysis Report Chapter 15 in 1990, it was identified that the current Supplementary Safety System (SSS) may not be adequate in protecting the reactor during the process water pump coastdown initiated by a loss of AC power when the safety rods are assumed to fail. A SSS modification project was initiated to add an additional ink injection pathway near the pump suction. In addition, the Department of Energy raised a question on the thermal buoyancy effects on moderator flow pattern and ink dispersion in the moderator space. The development and documentation of a two-dimensional code called MODFLOW was undertaken to describe the problem. This report discusses the results of the moderator flow and ink (Gadolinium Poison Solution - GPS) dispersion tests designed to provide qualified data for validation and benchmarking of the MODFLOW computer code with the secondary objectives being the development of concentration profiles and video footage of simulated GPS dispersion under steady-state and transient flow conditions.

6749 (WSRC-TR–93-580) **Calculation of seismic Severe Core Melt Frequency using internal event models for K reactor.** Taylor, R.P. Jr.; Wingo, H.E. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004035. Source: OSTI; NTIS; GPO Dep.

This report discusses a new method of calculating the seismic contribution to the Severe Core Melt Frequency (SCMF) of operating the K Production Reactor at the Savannah River Site (SRS) which has been developed. The methodology provides a direct link between the seismic analysis and the internal events PSA and facilitates the seismic analysis if a Level 1 internal events PSA exists for a facility. It improves the accuracy of the SCMF calculations and allows evaluation of the effects of seismic plant equipment and procedure modifications on the SCMF.

24 POWER TRANSMISSION AND DISTRIBUTION

2402 Power System Networks, Transmission and Distribution

Refer also to citation(s) 7913

6750 (UCRL-ID–115160) **Electric utility system master plan.** Erickson, O.M. Lawrence Livermore National Lab., CA (United States). Oct 1992. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004808. Source: OSTI; NTIS; GPO Dep.

This publication contains the electric utility system plan and guidelines for providing adequate electric power to the various facilities of Lawrence Livermore National Laboratory in support of the mission of the Laboratory. The topics of the publication include general information on the current systems and their operation, a planning analysis for current and future growth in energy demand, proposed improvements and expansions required to meet long range site development and the site's five-year plan.

2403 Power Transmission Lines and Cables

6751 (DOE/BP–2081) **Electric power lines: Questions and answers on research into health effects.** USDOE Bonneville Power Administration, Portland, OR (United States). Nov 1993. 48p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94005637. Source: OSTI; NTIS; GPO Dep.

Most people know that electric power lines, like the wiring in our homes, can cause serious electric shocks if we're not careful. Many people also want to know whether the electric and magnetic fields (EMF) produced by power lines and other electrical devices cause health effects. The purpose of this pamphlet is to answer some common questions that the Bonneville Power Administration (BPA) receives about the possible effects of power lines on health. (BPA is the Pacific Northwest's Federal electric power marketing agency.) First, some basic electrical terms are defined, and electric and magnetic fields are described. Next, answers are given to several questions about recent scientific studies. We then describe how BPA is addressing public concerns raised by these studies. Some important information about electrical safety follows. The last section tells you how to obtain more detailed information about the health and safety issues summarized in this pamphlet.

2405 Environmental Aspects

6752 (DOE/EIS–0159) **Flatiron-Erie 115kV transmission line project, Larimer, Weld and Boulder Counties, Colorado: Draft environmental impact statement.** USDOE Western Area Power Administration, Loveland, CO (United States). Loveland Area Office. May 1993. 300p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003358. Source: OSTI; NTIS; INIS; GPO Dep.

Western Area Power Administration (Western) proposes to uprate its existing 115-kV Flatiron-Erie transmission line. The line is located in Larimer, Weld and Boulder Counties, Colorado, and passes through the City of Longmont. The line connects Flatiron Substation and several of the substations supplying Longmont. It is a single circuit 115-kV line, 31.5 miles long, and was built in 1950-51 on a 75-foot wide right-of-way (ROW) using wood H-frame structures. Western proposes to build 27 new structures along the

line, to replace or modify 45 of the existing structures and to remote 11 of them. Many of these additions and changes would involve structures that are approximately 5 to 15 feet taller than the existing ones. The existing conductors and ground wires would remain in place. The purpose of these actions would be to allow the power carrying capability of the line to be increased and to replace deteriorating/structural members. Western would be the sole participant in the proposed project. This report gives an analysis of the study area environment and the development of alternative routes. An assessment is presented of the impacts of the primary alternative routes. The environmental consequences of this project are addressed.

2406 Legislation and Regulations

6753 (NEI-SE–132) **Anti-trust laws and the electricity market.** Danielsson, I.M.; Diczfalusy, B.; Eriksson, Carl; Henricson, L.; Szatek, K. Swedish Competition Authority, Stockholm (Sweden). Feb 1993. 26p. (In Swedish). Order Number DE94730425. Source: OSTI; NTIS.

The competition (anti-trust) laws of the European Economic Space treaty and of Sweden (dated July 1:st 1993) are briefly reviewed. Probable effects on the electricity market from these laws are discussed, i.e. applicability on transmission and distribution networks (including export/import) and on deliveries. Finally, two questions that will become acute at the deregulation of the power market are treated: what protection can small consumers get under the new laws, and what position will small producers get.

2407 Economic, Industrial, and Business Aspects

6754 (DOE/BP–2008) **Bonneville Power Administration's commercial sector conservation market.** Gordan, F.M. (Pacific Energy Associates, Inc. (United States)). USDOE Bonneville Power Administration, Portland, OR (United States). 10 Nov 1992. 70p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003505. Source: OSTI; NTIS; GPO Dep.

Bonneville has, as part of its resource plan, accepted targets for commercial conservation which are quite ambitious. To meet these targets, Bonneville will need to acquire as much cost-effective conservation as possible over the next twelve years. With this in mind, this document explores the relative importance of different commercial market segments and the types of assistance each market needs to install as many cost-effective conservation measures in as many buildings as possible. This document reviews Bonneville's marketing environment and position, and suggests goals for commercial sector conservation marketing at Bonneville. Then it presents a broad market segmentation and series of additional demographic analyses. These analyses assess what groups of consumers Bonneville must reach to achieve most of the commercial conservation potential and what is needed to reach them. A final section reviews the success of Bonneville programs at reaching various markets. The market segmentation identifies different types of consumers and opportunities which would require distinct program approaches. Four large market segments are identified that have distinct program needs. Then four "building life-cycle events" are identified which provide important conservation opportunities and also require distinct program services. This creates a matrix of 16 cells which delineate distinct needs for program marketing. Each of the four key market segments manages at least 20% of the Region's commercial floorspace.

6755 (DOE/EIA–0226(93/10)) **Electric power monthly, October 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. 20 Oct 1993. 222p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94002222. Source: OSTI; NTIS; GPO; GPO Dep.

The Electric Power Monthly (EPM) presents monthly electricity statistics. The purpose of this publication is to provide energy decisionmakers with accurate and timely information that may be used in forming various perspectives on electric issues that lie ahead. Data in this report are presented for a wide audience including Congress, Federal and State agencies, the electric utility industry, and the general public. The EIA collected the information in this report to fulfill its data collection and dissemination responsibilities as specified in the Federal Energy Administration Act of 1974 (Public Law 93-275) as amended. This publication provides monthly statistics at the US, Census division, and State levels for net generation, fossil fuel consumption and stocks, quantity and quality of fossil fuels, cost of fossil fuels, electricity sales, revenue, and average revenue per kilowatthour of electricity sold. Data on net generation, fuel consumption, fuel stocks, quantity and cost of fossil fuels are also displayed for the North American Electric Reliability Council (NERC) regions. Statistics by company and plant are published in the EPM on the capability of new generating units, net generation, fuel consumption, fuel stocks, quantity and quality of fuel, and cost of fossil fuels.

6756 (DOE/EIA–0226(93/11)) **Electric power monthly, November 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. 30 Nov 1993. 224p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003906. Source: OSTI; NTIS; GPO; GPO Dep.

The Electric Power Monthly (EPM) presents monthly electricity statistics. The purpose of this publication is to provide energy decisionmakers with accurate and timely information that may be used in forming various perspectives on electric issues that lie ahead. Data in this report are presented for a wide audience including Congress, Federal and State agencies, the electric utility industry, and the general public. The EIA collected the information in this report to fulfill its data collection and dissemination responsibilities as specified in the Federal Energy Administration Act of 1974 (Public Law 93-275) as amended. This publication provides monthly statistics at the US, Census division, and State levels for net generation, fossil fuel consumption and stocks, quantity and quality of fossil fuels, cost of fossil fuels, electricity sales, revenue, and average revenue per kilowatthour of electricity sold. Data on net generation, fuel consumption, fuel stocks, quantity and cost of fossil fuels are also displayed for the North American Electric Reliability Council (NERC) regions. Statistics by company and plant are published in the EPM on the capability of new generating units, net generation, fuel consumption, fuel stocks, quantity and quality of fuel, and cost of fossil fuels. Data on quantity, quality, and cost of fossil fuels lag data on net generation, fuel consumption, fuel stocks, electricity sales, and average revenue per kilowatthour by 1 month. This difference in reporting appears in the US, Census division, and State level tables. However, for purposes of comparison, plant-level data are presented for the earlier month.

25 ENERGY STORAGE

2501 Magnetic

6757 (ORNL/SUB–88-SM362/1) **Understanding Superconducting Magnetic Energy Storage (SMES) technology, applications, and economics, for end-use workshop.** Ferraro, R.J. (Ferraro, Oliver, and Associates, Inc., Knoxville, TN (United States)); McConnell, B.W. Oak Ridge National Lab., TN (United States); Ferraro, Oliver, and Associates, Inc., Knoxville, TN (United States). Jun 1993. 112p. Sponsored by USDOE, Washington, DC (United States);Electric Power Research Inst., Palo Alto, CA (United States). DOE Contract AC05-84OR21400. (CONF-9212104–: Understanding SMES technology, applications, and economics for end-use workshop, Atlanta, GA (United States), 2-3 Dec 1992). Order Number DE94003578. Source: OSTI; NTIS; GPO Dep.

The overall objective of this project was to determine the state-of-the-art and to what extent existing SMES is a viable option in meeting the needs of utilities and their customers for improving electric service power quality. By defining and analyzing SMES electrical/mechanical performance characteristics, and comparing SMES application benefits with competitive stored energy systems, industry will be able to determine SMES unique applications and potential market penetration. Building on this information base, it would also be possible to evaluate the impact of high temperature

superconductors (77 K and 20-35 K) on SMES technology applications. The authors of this report constructed a network of industry contacts and research consultants that were used to collect, update, and analyze ongoing SMES R&D and marketing activities in industries, utilities, and equipment manufacturers. These key resources were utilized to assemble performance characteristics on existing SMES, battery, capacitor, flywheel, and high temperature superconductor (HTS) stored energy technologies. From this information, preliminary stored energy system comparisons were accomplished. In this way, the electric load needs would be readily comparable to the potential solutions and applications offered by each aforementioned energy storage technology.

2506 Thermal

6758 (PNL-SA–21660) **Coadunation of technologies: Cogeneration and thermal energy storage.** Somasundaram, S.; Drost, M.K.; Brown, D.R.; Antoniak, Z.A. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930935–1: 7. American Society of Mechanical Engineers COGEN-TURBO power congress and exhibition, Bournemouth (United Kingdom), 21-23 Sep 1993). Order Number DE94004354. Source: OSTI; NTIS; GPO Dep.

Cogeneration is playing an increasingly important role in providing an independent and on-site high-efficiency source of power generation and thermal energy for space heating and cooling, as well as industrial process heat applications. However, the range of applications of cogeneration technology could be further extended if the generation of electricity could be decoupled from the generation of thermal energy for process use or space conditioning. The technology of thermal energy storage (TES) provides just such a decoupling that allows for the production of dispatchable power while fully utilizing the thermal energy available from the prime mover of the cogeneration system. The thermal energy from the prime mover exhaust can be stored either as sensible heat or as latent heat and used during peak demand periods to produce electric power or process steam/hot water. However, the additional materials and equipment necessary for a TES system will add to the capital as well as maintenance costs. Therefore, the economic benefits of adding TES to a conventional cogeneration system would have to outweigh the increased costs of the combined system. This paper addresses some of the TES systems that are readily applicable to be combined with cogeneration systems, as well as provide an update on the current status of these TES systems. TES allows a cogeneration facility to (1) provide dispatchable electric power while providing a constant thermal load, and (2) increase peak capacity by providing economical cooling of the combustion turbine inlet air. The particular systems addressed are high-temperature diurnal TES, and TES for cooling the combustion turbine inlet air.

2509 Batteries

6759 (ANL/CMT/CP–79723) **Reference electrodes for solid polymer electrolytes.** Johnson, C.S.; Dees, D.W. Argonne National Lab., IL (United States). [1993]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931024–1: 184. meeting of the Electrochemical Society, New Orleans, LA (United States), 10-15 Oct 1993). Order Number DE94004583. Source: OSTI; NTIS; GPO Dep.

Electrochemical experiments were conducted on a binary metallic lithium-tin alloy that may be suitable as a reference electrode of the first kind in studies of lithium-polymer batteries. Two types of tin electrodes were tested: bulk tin foil and tin thin films deposited on a stainless steel substrate. Electrochemical test cells were fabricated, with tin, metallic lithium, poly(ethylene oxide), and lithium trifluoromethanesulfonate as electrodes and polymer electrolyte material. To form the alloy, the tin electrodes were galvanostatically loaded in situ with lithium. Each cell reached one or more steady-state voltage plateaus during the electrochemical reduction of lithium cations at the tin electrode surface. The lithiated tin foil electrode (1 C/cm^2 of charge passed; area $\approx$ 5 cm^2; thickness = 1.0 mm) demonstrated good voltage stability over months under open-circuit conditions. This electrode maintained an average open circuit voltage of 0.7336 V with only $\pm$0.17 mV variance. Composition of phases in the thin film electrodes (x in Li_xSn) was coulometrically varied via reversible lithium loading and unloading reactions. Results show that three different, two-phase compositions may be formed that maintain flat voltage regions at approximately 0.53, 0.63, and 0.73 V vs lithium metal.

6760 (ANL/CMT/CP–79729) **A shuttle mechanism for molten-electrolyte lithium batteries.** Kaun, T.D.; Nelson, P.A. Argonne National Lab., IL (United States). [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931024–5: 184. meeting of the Electrochemical Society, New Orleans, LA (United States), 10-15 Oct 1993). Order Number DE94002914. Source: OSTI; NTIS; GPO Dep.

The lithium-transport rates arising from a lithium shuttle mechanism (LSM) were examined by potentiometric control of a lithium-alloy electrode in a temperature range of 400 to 515°C in three electrolytes: LiCl-KCl, LiCl-LiBr-KBr, and LiF-LiCl-LiBr. Lithium transport in Li/FeS_x cells by LSM was found to occur by diffusion of reduced lithium species across the separator layer, which was controlled by the Li-activity of the Li-alloy electrode. Solubility of lithium was strongly affected by electrolyte composition, especially K^+ content, which in turn regulated the lithium transport rate. As evidenced by LSM rates, the solubilized lithium would appear to form dimers (e.g. Li_2^+ or LiK^+). The half-cell self-discharge rates, which were measured, correlate well with self-discharge rates in developmental cells ranging from 0.1 to 10 mA/cm^2. Innovative application of the LSM has led to the development of overcharge tolerant Li/FeS_x cells. A bimodal self-discharge characteristic (a 20-fold increase toward the end of charge) results from a 150-250 mV step increase in lithium activity of a two-phase Li-alloy electrode (Li-Al plus Li-Al_5Fe_2). Three versions of the battery cell (100 cm^2 separator area) have been demonstrated: LiAl+$Li_5Al_5Fe_2$(10% of capacity)/LiCl-LiBr-KBr(MgO)/FeS_2, as well as a FeS-type, (both operated at 400°C) and LiAl+$Li_5Al_5Fe_2$(10% of capacity)/LiF-LiCl-LiBr(MgO)/FeS (operated at 475°C). These cells exhibit a unique combination of overcharge capacity and extended trickle-charge tolerance at 2-5 mA/cm^2. Additionally, Li/FeS_2 cells having overcharge tolerance have operated with stable performance for greater than 500 cycles. The overcharge tolerance rates are sufficient for battery cells to exhibit built-in charge/equalization capability by way of full-battery trickle charging.

6761 (DOE/FTR–93018325) **Travel to Germany, France, and the UK to review battery technologies: Foreign trip report, July 6–20, 1991.** Butler, P.C. Sandia National Labs., Albuquerque, NM (United States). 22 Jul 1991. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93018325. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Purpose of the trip was to accompany members of U.S. Advanced Battery Consortium on technical fact-finding visits to four electric vehicle battery developers in Europe. Berlin Power and Light was also visited to tour the 8.5 MW/14.4 MWh lead-acid battery used for frequency regulation on the Berlin utility grid. A meeting was also held with Michel Armand in Paris to discuss lithium-polymer battery technology for electric vehicle applications.

6762 (DOE/FTR–93018330) **Travel to Japan for conference on Battery Energy Storage for electric utilities: Foreign trip report, March 8–23, 1991.** Akhil, A.A. Sandia National Labs., Albuquerque, NM (United States). 8 Apr 1991. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93018330. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Purpose of the trip was to visit Japanese government and industry officials to evaluate progress and plans for utility storage battery research, and to attend and present a paper at the 3rd International Conference on Batteries for Utility Energy Storage. Battery types covered include sodium/sulfur, lead-acid, and zinc/bromine.

6763 (DOE/FTR–94002464) **Travel to Germany and the UK for meetings on storage battery research: Foreign trip report, September 26–October 5, 1993.** Butler, P.C.; Jungst, R.G. Sandia National Labs., Albuquerque, NM (United States). 15 Oct 1993.

31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE94002464. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The Fourth International Conference on Batteries for Energy Storage was attended, three papers were presented, and one session was co-chaired. The Conference was attended by about 60 people from Europe, Asia, and the United States, representing utilities, battery manufacturers, power electronics manufacturers, and government research organizations. The major issues discussed at the meeting concerned the cost effectiveness of battery systems in utility applications, improving the understanding of the benefits of battery storage by utilities, and uncertainty about the advantages of advanced batteries for these applications. Sandia and several of its contractors presented all aspects of the DOE Utility Battery Storage Systems (UBS) Program and were well received. Three sites around Berlin were visited that related to electric energy generation, transmission, and storage. Silent Power Ltd. (SPL), Runcorn, UK, was visited for one day to discuss and review sodium/sulfur battery development. SPL and its US subsidiary are under contract to Sandia to develop this battery technology. Utility battery applications, battery development, and battery testing were discussed. SPL has made significant progress in the area of battery engineering. Several areas were identified where Sandia might assist SPL under a Work for Others (WFO) agreement. The SPL facilities in Runcorn were toured briefly.

6764 (NUTEK–90-696) **Advanced electric-car batteries: Testing.** Widen, K.B. (Catella Generics AB, Kista (Sweden)). Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). Aug 1991. 25p. (In Swedish). Order Number DE94730440. Source: OSTI; NTIS.

Three different types of batteries for electric vehicle propulsion have been evaluated, two types of nickel/cadmium batteries and a lead battery. The testing includes initial characterization with capacity determination at constant discharge, as well as determination of the inner resistance during discharge and charging, as a function of the batterys discharge depth. Also studied was the battery behavior during dynamic discharge/sequences, with RWE-profile and with hybrid vehicle profile. 20 figs, 9 tabs

29 ENERGY PLANNING AND POLICY

6765 (DOE/S–0106P) **Semiannual report to Congress on Inspector General audit reports, April 1, 1993–September 30, 1993.** USDOE, Washington, DC (United States). Nov 1993. 22p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003679. Source: OSTI; NTIS; GPO Dep.

This is the Secretary of Energy's ninth Semiannual Report to Congress to be submitted under the Inspector General Act of 1978, as amended. Pursuant to the Inspector General Act Amendments of 1988 (Public Law 100-504), agency heads are to report to Congress on the status of final action taken on audit report recommendations. This report complements a report prepared by the Department's Office of Inspector General that provides information on audit reports issued during the period and on the status of management decisions made on Inspector General audit reports. During the period covered by this report, April 1 through September 30, 1993, the Department took final action on four contract and financial assistance audit reports. At the end of the period only three reports awaited final action. With regard to operational, financial, and preaward audits, final action was taken on 41 reports, resulting in 93 audit reports needing final action at the end of the period.

2901 Energy Analysis and Modeling

Refer also to citation(s) 6831, 6920

6766 (DOE/EIA–M057) **NEMS integrating module documentation report.** USDOE Energy Information Administration, Washington, DC (United States). Office of Integrated Analysis and Forecasting. 14 Dec 1993. 113p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94005135. Source: OSTI; NTIS; GPO Dep.

The National Energy Modeling System (NEMS) is a computer modeling system that produces a general equilibrium solution for energy supply and demand in the US energy markets. The model achieves a supply and demand balance in the end-use demand regions, defined as the nine Census Divisions, by solving for the prices of each energy type such that the quantities producers are willing to supply equal the quantities consumers wish to consume. The system reflects market economics, industry structure, and energy policies and regulations that influence market behavior. The NEMS Integrating Module is the central integrating component of a complex modeling system. As such, a thorough understanding of its role in the modeling process can only be achieved by placing it in the proper context with respect to the other modules. To that end, this document provides an overview of the complete NEMS model, and includes brief descriptions of the modules with which the Integrating Module interacts. The emphasis and focus, however, is on the structure and function of the Integrating Module of NEMS.

2902 Economics and Sociology

Refer also to citation(s) 6254, 6437, 6438, 6439, 6440, 6459, 6463, 6510, 6513, 6776, 6777, 6778, 6779, 6781, 6798, 6799, 6813, 6817, 6837, 6855, 6867, 6917, 6921, 7492

6767 (CMR–92-A30009) **Misperception and mismanagement of the greenhouse effect?: The simulation model.** Hatlebakk, M.; Moxnes, E. Christian Michelsen Research A/S, Bergen (Norway). Dec 1992. 25p. Order Number DE94730386. Source: OSTI; NTIS; INIS.

We present a stochastic simulation model of the world economy, useful for the analysis of climate policy. The model will also be used in an experiment to investigate the ability of policy makers to tackle the greenhouse problem. Preliminary simulations are conducted to find an optimal stationary tax rate. 30 refs., 6 figs., 10 tabs.

6768 (CONF-9206415–) **Visions for a sustainable world: A conference on science, technology and social responsibility: Conference report.** Student Pugwash U.S.A., Washington, DC (United States). [1992]. 157p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-92ER61375. From 7. Student Pugwash USA's international conference on visions for a sustinable world; Atlanta, GA (United States); 14-20 Jun 1992. Order Number DE94001664. Source: OSTI; NTIS; GPO Dep.

This report summarizes the organization, activities, and outcomes of Student Pugwash USA's 1992 International Conference, Visions for a Sustainable World: A Conference on Science, Technology and Social Responsibility. The conference was held June 14–20, 1992 at Emory University, and brought together 94 students and over 65 experts from industry, academe, and government. The conference addressed issues ranging from global environmental cooperation to the social impacts of the Human Genome Project to minority concerns in the sciences. It provided a valuable forum for talented students and professionals to engage in critical dialogue on many interdisciplinary issues at the juncture of science, technology and society. The conference challenged students – the world's future scientists, engineers, and political leaders – to think broadly about global problems and to devise policy options that are viable and innovative. The success of the conference in stimulating interest, understanding, and enthusiasm about interdisciplinary global issues is clearly evident from both the participants' feedback and their continued involvement in Student Pugwash USA programs. Six working groups met each morning. The working group themes included: environmental challenges for developing countries; energy options: their social and environmental impact; health care in developing countries; changing dynamics of peace and global security; educating for the socially responsible use of technology; ethics and the use of genetic information. The conference was specifically designed to include mechanisms for ensuring its long-term impact. Participants were encouraged to focus on their individual role in helping resolve global issues. This was achieved through each participant's development of a Personal Plan of Action, a plan which mapped out activities the student could undertake after the conference to continue the dialogue and work towards the resolution of global and local problems.

6769 (DOE/EH–0193P) **Organizational cultural assessment of the Sandia National Laboratories.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). May 1991. 120p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94005003. Source: OSTI; NTIS; GPO Dep.

An Organizational Cultural Assessment (OCA) was performed at the Sandia National Laboratories (SNL) by administering an Organizational Culture Survey (OCS) that queried employees on the subjects of organizational culture, various aspects of communications, employee commitment, work group cohesion, coordination of work, environmental concerns, hazardous nature of work, safety, and overall job satisfaction. The purpose of the OCS is to measure in a quantitative and objective way the values, attitudes, and beliefs of the individuals working within the organization. The OCS administration at SNL was the fifth to occur at a DOE facility. The sample was randomly selected from each Vice Presidency group, the largest organizational unit at SNL. Scores and significance are discussed and statistically significant differences between groups are identified and discussed.

6770 (DOE/EIA–0543(93/3Q)) **US energy industry financial developments, 1993 third quarter.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Dec 1993. 18p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004816. Source: OSTI; NTIS; GPO Dep.

Based on information provided in 1993 third quarter financial disclosures, the average net income for 112 petroleum companies – including 18 majors – rose 13 percent between the third quarter of 1992 and the third quarter of 1993. The gain in overall petroleum income was derived from increases in refined product consumption and margins, which improved the profitability of downstream petroleum (refining, marketing and transport) operations. A 17-percent decline in crude oil prices led to reduced income for upstream (oil and gas exploration, development and production) operations. A 16-percent rise in natural gas wellhead prices only partially offset the negative effects of low crude oil prices. Electric utilities also reported improved financial results for the third quarter of 1993 as hotter summer temperatures relative to the year-earlier quarter helped boost air conditioning demand and overall electricity usage. The following points highlight third-quarter energy industry financial developments: (1) Refined product demand and margins lift downstream earnings. Petroleum product consumption rose 2 percent between the third quarter of 1992 and the third quarter of 1993. Although petroleum product prices declined in the most recent reporting period, they did not decline as much as crude oil input prices. As a consequence, refined product margins widened. (2) Lower crude oil prices reduce upstream earnings. Crude oil prices fell 17 percent between the third quarter of 1992 and the third quarter of 1993 leading to a substantial reduction in income for the major petroleum companies' upstream operations. (3) Drilling income rises with increased North American exploratory activity.

6771 (NREL/CP–200-5768-Vol.2, pp. 910-915) **Cost implications of feedstock combinations for community sized biodiesel production.** Weber, J.A. (Univ. of Missouri, Columbia, MO (United States)); Van Dyne, D.L. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Biodiesel can be processed from oilseeds or animal fats and used in unmodified diesel engines. This fuel has been produced commercially in Europe for three years. Research indicates that biodiesel can replace diesel fuel without causing harmful effects to an unmodified engine and can reduce harmful emissions . Some European biodiesel plants operate at the community level effectively supplying both fuel and animal feeds. This study examines multiple feedstocks that could be utilized by a community sized biodiesel plant. The model plant used is a 500,000 gallon processing facility. The model plant is assumed to be installed in an existing grain handling facility or feed mill. Animal fats would be purchased from outside sources and oilseeds would be provided by area producers. Producers would retain ownership of the oilseeds and pay a processing fee to the cooperative. Oilseeds would be extruded before being separated into meal and crude oil. The crude oil would be esterified into biodiesel using continuous flow esterification technology. This study concludes under specific conditions, biodiesel can be processed economically at the community level. The results indicate that without farm program benefits to minor oilseeds, soybeans are the most economic feedstock to use in a community based operation. Realistic price information suggests that biodiesel (from soybeans) could be produced for $1.26 per gallon. If producers participate in government programs and are capable of growing minor oilseeds, canola may represent a better feedstock than soybeans. Achieving the lowest costs of production depends on the value assigned to co-product credits such as oilseed meal. The more producers pay for high protein meal for their livestock and poultry, the lower the residual price of biodiesel.

6772 (NREL/CP–200-5768-Vol.2, pp. 1010-1031) **An overview of ethanol production for transportation fuels.** Wyman, C.E. (National Renewable Energy Lab., Golden, CO (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Ethanol can be produced from plentiful indigenous renewable resources including corn and other starch crops and lignocellulosic biomass, thereby reducing our strategic vulnerability to unstable oil supplies while significantly improving our balance-of-trade deficits, domestic employment, and farm economy. Use of ethanol as a direct blend, a component in ethyl tertiary butyl ether, or a neat fuel improves our air quality. Ethanol production from lignocellulosic biomass also contributes significantly less carbon dioxide accumulation to the atmosphere than fossil fuels, reducing the possibility of global climate change. Currently, about 3.8 GL (1.0 billion gallons) of ethanol is derived from corn and other starch crops each year in the United States. Technology has also been developed for producing ethanol from lignocellulosic biomass that could be competitive now, particularly for low-cost feedstocks and other niche markets. Opportunities have also been defined to reduce the cost of ethanol production from lignocellulosic biomass to be competitive with gasoline within ten years without tax incentives.

6773 (PNL-SA–23122) **Integrating climate change into energy demand forecasts: A commercial sector analysis.** Scott, M.J.; Belzer, D.B.; Hadley, D.L.; Wrench, L.E. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9310234–1-Vugraphs: International Association for Energy Economics North American conference, Seattle, WA (United States), 11-13 Oct 1993). Order Number DE94003705. Source: OSTI; NTIS; GPO Dep.

This study examines the effects of global climate change on commercial building energy use. The methodology used included estimating balance points and degree-day response coefficients, estimating cross-section regressions to extrapolate to a full sample, extrapolating the building sample to the year 2030, and estimating the energy consumption in the year 2030 under different temperature regimes. Results show that total primary energy consumption in U.S. commercial buildings will rise although the absolute increase in consumption may not be large, given offsetting heating benefits. Nonetheless, the effect on electric utilities may be severe.

2903 Environment, Health, and Safety

Refer also to citation(s) 6065, 6105, 6155, 6234, 6257, 6262, 6268, 6752, 6768, 6773, 6798, 6799, 6800, 6801, 6815, 6821, 6920, 7492

6774 (DOE/EH–0352) **CERCLA Site Assessment questions and answers (Qs&As).** Traceski, T.T. USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC

(United States). RCRA/CERCLA Div. 9 Nov 1993. 6p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003881. Source: OSTI; NTIS; GPO; GPO Dep.

This documents contains commonly asked questions and corresponding answers (Qs&As) on the CERCLA Site Assessment process. These questions were derived from DOE element responses to a solicitation calling for the identification of (unresolved) issues associated with the conduct of CERCLA site assessments, and from inquiries received during a series of Site Assessment Workshops provided by the Environmental Protection Agency (EPA) and the Office of Environmental Guidance, RCRA/CERCLA Division (EH-231). Answers to these questions were prepared by EH-231 in cooperation with the EPA Federal Facilities Team in Office of Solid Waste and Emergency Response, Site Assessment Branch, and in coordination with the Office of Environmental Compliance, Facilities Compliance Division (EH-222).

6775 (DOE/EIS–0145-App.) **Non-federal participation in AC Intertie Draft Environmental Impact Statement: Appendices.** USDOE Bonneville Power Administration, Portland, OR (United States). [1993]. 474p. Sponsored by USDOE, Washington, DC (United States). (DOE/BP–2119). Order Number DE94001269. Source: OSTI; NTIS; GPO Dep.

This report discusses various impacts that the Bonneville Power Administration has on the environment. Appendices are included on the following topics: life-of-facilities capacity ownership proposal; long-term Intertie access policy; glossary; biological assessment and supporting materials; environmental impacts of generic resource types; technical information on analysis methods and results; affected environment supporting documentation; public involvement activities; and a bibliography.

6776 (DOE/ER/61010–T24) **Developing methodology and tools for integrated assessment of the risks of global environmental change: Analyzing uncertainty, risk assessment, risk perception, expert judgment, and a case study on sea level rise: Report of collaborative research, July 1991–June 1993: Final report.** Lancaster, J. (Harvard Univ., Cambridge, MA (United States)); Shlyakhter, A.; Wilson, R. (eds.). National Inst. for Global Environmental Change, Cambridge, MA (United States). Northeast Regional Center. [1993]. 93p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC03-90ER61010. Order Number DE94003830. Source: OSTI; NTIS; INIS; GPO Dep.

Members of Congress, federal administrators, state regulators, city planners, corporate strategists and private citizens face decisions that may or may not warrant considering the potential impacts of climate change. The extent to which the global warming issue will weigh in these many decisions will be determined by (a) expert scientific judgement about global warming and its potential impacts, (b) public perception of the global warming problem, (c) uncertainties, and (d) other legal and political factors controlling the entry of a large-scale environmental issue into many avenues of decision making. The complexity and uncertainty surrounding the problem of climate change present new challenges to our ability to formulate rational decisions. The authors provide a methodical approach to characterizing the risks of global warming in a way that will be useful to decision makers.

6777 (DOE/EW/50625–T5) **[Environmental Hazards Assessment Program annual report, June 1992–June 1993]: Needs assessment for the proposed masters degree program in environmental science at the Medical University of South Carolina: EHAP Volume 1, No. 2.** Hoomani, J. Medical Univ. of South Carolina, Charleston, SC (United States). 1 May 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE94004508. Source: OSTI; NTIS; INIS; GPO Dep.

There will be a critical shortage of professionals who are educated to deal with environmental problems by 1997. This was the major finding of a 1992 study conducted by the Oak Ridge Associated Universities, Incorporated and the Pacific Northwest Laboratory (Publication Number PAL-8171, CU-700). The study was done to determine the manpower needs of the Office of Environmental Restoration and Waste Management in the US Department of Energy (DOE). Although the focus of the study was the 19 sites of the DOE complex, including the Savannah River Site in South Carolina, the study documented that such shortages will affect other major agencies and organizations including the US Department of Interior, the US Department of Defense, the Environmental Protection Agency, state and local governmental agencies, private agencies, and manufacturing enterprises throughout the State of South Carolina and the National. The Oak Ridge Study also documented that a variety of professional positions requiring environmental expertise are difficult to fill because traditional educational programs in physical science, engineering, health science, public policy, and administration have not adequately responded to the unique nature of these emerging specialities. This lack of educational preparation has necessitated extensive on-site training of new employees before they can become productive members of the environmental work force. Unique educational initiatives such as the Environmental Studies program proposed here are vital to address the long-term demand for environmental professionals.

6778 (DOE/EW/50625–T9) **[Environmental Hazards Assessment Program annual report, June 1992–June 1993]: Proposal for a new program leading to the Master of Science degree in environmental studies to be offered jointly by the Medical University of South Carolina and the University of Charleston, South Carolina.** Medical Univ. of South Carolina, Charleston, SC (United States). [1993]. 72p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE94004504. Source: OSTI; NTIS; INIS; GPO Dep.

The Medical University of South Carolina (MUSC) and the University of Charleston, South Carolina (UCSC) propose to offer the degree of Master of Science in Environmental Studies. The proposed starting date is August 1994. The purpose of this interdisciplinary program is to offer nationally and internationally recognized graduate level training in the areas of environmental policy, science, and health risk assessment. Special emphasis will be placed on human health. Included in this proposal are a needs assessment for environmental science professionals along with employment projections and salary expectations. The Environmental Science program is described and its relationship to other programs within MUSC and UCSC, as well as its relation to similar programs at other institutions are examined. Enrollment is discussed, admission requirements and standards outlined, and the curriculum is described. Academic and physical resources are examined and estimated costs are given.

6779 (DOE/EW/50625–T10) **[Environmental Hazards Assessment Program annual report, June 1992–June 1993]: Summer undergraduate research program: Environmental studies.** McMillan, J. (ed.). Medical Univ. of South Carolina, Charleston, SC (United States). [1993]. 149p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE94004503. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the summer undergraduate internship program for research in environmental studies is to provide an opportunity for well-qualified students to undertake an original research project as an apprentice to an active research scientist in basic environmental research. Ten students from throughout the midwestern and eastern areas of the country were accepted into the program. These students selected projects in the areas of marine sciences, biostatistics and epidemiology, and toxicology. The research experience for all these students and their mentors was very positive. The seminars were well attended and the students showed their interest in the presentations and environmental sciences as a whole by presenting the speakers with thoughtful and intuitive questions. This report contains the research project written presentations prepared by the student interns.

6780 (DOE/FTR–93018178) **Discussions with the Soviet Union concerning environmental technologies and management policy: Foreign trip report, August 2–24, 1991.** Lesperance, A.M. Pacific Northwest Lab., Richland, WA (United States). 24 Sep 1991. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE93018178. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The first week of meetings were held in Moscow with regulatory and research scientists. Topics discussed included chemical substitution in industries, environmental policy development, recycling of municipal waste polymers, solid waste management, and energy pollution control technologies. Issues addressed in Kharkov and Kiev included environmental management, environmental education, solid waste management, nuclear power and environmental impacts of the Chernobyl accident. In St. Petersburg, water and air quality issues, industrial pollution prevention strategies, radionuclide modeling, and environmental policy development issues were addressed. Ann Lesperance returned to Moscow on August 18 to meet Tom Brouns (PNL) and Leonid Valentinov (Supreme Soviet deputy). Mr. Valentinov invited Ms. Lesperance and Mr. Brouns to participate in private discussions with environmental professionals on August 18 and 19. Although the coup attempt occurred on August 18, only one meeting was cancelled in Moscow during those 2 days. Throughout the discussions, Soviet representatives identified many technical areas for possible future collaboration with PNL and DOE. These areas are highlighted in the detailed report.

6781 (ETDE-IT–93-248) **Technology and society: Impact and adjustment perspectives.** Gadomska, M. No corporate text available. Apr 1993. 58p. Quaderni Studi 17. Order Number DE94727342. Source: OSTI; NTIS (US Sales Only).

Due to ever increasing social demand for more decentralized decision making in the field of technological risk regulation, many social actors from different backgrounds, e. g., industry, scientific research, national and local governments, volunteer organizations, etc., are becoming involved in the decision making processes. This mix of interested parties brings about competing cognitive perspectives and conflicting interests. Thus, there is the need for a participatory approach to risk definition and management which requires that all social actors who have a vested stake in an actual or proposed utilization of technology have the possibility to express their points of view. In addition to cultural/social preparedness on the part of the decision makers, the successful application of participatory methodologies also necessitates a certain level of technological preparedness which can be acquired through the effective implementation of information technology support systems. Within this context, this paper develops a unified perspective on issues such as environmental management, emergency planning and technological risk assessment. It discusses design and application aspects of computerized information support systems and makes suggestions on how to design information technology tools to make them fit naturally and effectively into social organizational structures.

6782 (FERC/FEIS–0067) **Proposed modifications to the Lower Mokelumne River Project, California: FERC Project No. 2916-004: Final environmental impact statement.** USDOE Federal Energy Regulatory Commission, Washington, DC (United States). Project Compliance and Administration Div. Nov 1993. 630p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. (ORNL/M–3156). Order Number DE94003998. Source: OSTI; NTIS; INIS; GPO Dep.

This final environmental impact statement (FEIS) has been prepared for the Federal Energy Regulatory Commission (Commission) to consider modifications to the existing Lower Mokelumne River Project (LMRP) (FERC Project No. 2916-004) in California. Chinook salmon and steelhead trout populations in the lower Mokelumne River have experienced recent declines and fish kills associated, in part, with discharges from Camanche Dam. The California Department of Fish and Game and the California Sportfishing Protection Alliance have asked the Commission to investigate and correct these problems. A wide range of different mitigation actions has been proposed by parties participating in the scoping of this proceeding, and staff has evaluated these proposed actions in this assessment. The staff is recommending a combination of flow and non-flow modifications to the existing license, including new minimum flow and minimum pool elevation requirements at Camanche Reservoir, ramping rates on dam releases, interim attraction and out-migrant spike flows, instream habitat improvements, and a series of studies and monitoring to determine feasible means for solving off-site fish passage problems.

6783 (KFK–5197) **Political ways to the reduction of global carbon dioxide emissions.** Kopfmueller, J.; Socher, M.; Fleischer, T.; Rieken, T. Kernforschungszentrum Karlsruhe GmbH (Germany). Abt. fuer Angewandte Systemanalyse. May 1993. 86p. (In German). Order Number DE94734100. Source: OSTI; NTIS (US Sales Only).

In the report presented here the resolution of the Framework Convention on Climate Change signed while the United Nations Conference on Environment and Development in June 1992 in Rio, calling for measures designed to reduce the emission of greenhouse gases, is analysed with respect to its feasibility. A comparative description of the policies and the positions of the United States, Germany, Japan, China and the European Community reveals grave differences regarding extend and realization of climate protection targets. Yet known and discussed methods and instruments of carbon dioxide emission allocation and reduction are discribed and analysed with regard to their effectiveness. It is shown that carbon dioxide removal and disposal techniques do not currently represent major reduction potentials. Finally the major features of a law for the Federal Republic of Germany designed to reduce carbon dioxide emissions are outlined, rendering it possible to achieve the reduction goals planned by the German government for the year 2005 in an economically and socially tolerable manner. (orig.)

6784 (LUTFD2-TFEM–93-1003) **Energy systems and climate change: Approaches to formulating responses.** Wilson, Deborah. Lund Inst. of Tech. (Sweden). Dept. of Environmental and Energy Systems Studies. Apr 1993. 12p. Order Number DE94730405. Source: OSTI; NTIS; INIS.

A method is presented for computing the direct and indirect radiative forcings of emissions of carbon dioxide, nitrous oxide and methane and comparing them in terms of their carbon-equivalent radiative forcing potential as a common unit. Examples illustrate application of the method in comparisons of the carbon-equivalent emissions from coal-, oil- and natural gas-based electricity and combined heat and power production assuming near-, medium- and long-term perspectives. The second article provides a systematic approach to calculating the net cost of avoiding greenhouse-gas emissions by adopting individual supply- and demand-side fuel switching and energy efficiency measures instead of proceeding down business as usual energy paths. Individual measures are grouped and ranked to form scenario packages for total and average costs of avoided carbon equivalent emissions. Examples are presented for Sweden, the United States and the state of Karnataka, India. A key finding is that there appears to exist significant emission avoiding potential that can be exploited at a net economic benefit to society. This potential is insufficient, however, to stabilize atmospheric concentrations of the greenhouse gases. The suggestion that changes can be made to energy systems leading to significant levels of avoided carbon dioxide emissions at little or no cost to society has been refuted by economic theoreticians, whose writings warn that policies aimed at avoiding greenhouse gas emissions will incur exorbitant costs. A case study of the potential to use ethanol produced from sugar cane as a transportation fuel in Thailand is used to illustrate an integrated approach to evaluating components of alternative energy systems.

6785 (NEI-DK–1373-Vol.1, pp. 6-19) **The challenge of sustainable development to democracy, global cooperation and the use of technology.** Tinker, J. Teknologinaevnet, Copenhagen (Denmark). 1993. (CONF-9211286–Vol.1: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). In *Technology and democracy. Vol. 1: The use and impact of technology assessment in Europe. Proceedings.* 351p. Order Number DE94730319. Source: OSTI; NTIS.

The president of The Panos Institute discusses in general the subjects of the challenge of sustainable development to democracy, a global cooperation and the use of technology with reference to the Earth Summit in Rio de Janeiro, the activities of the Panos Institute, and the involvement of the public in decision making regarding the utilization of technology. He claims that development can never be sustainable if it reinforces or increases massive inequality. (AB)

6786 (NEI-DK–1373-Vol.1, pp. 183-188) **Danish environmental policy - experiences on cleaner technology.**

Kristoffersen, S. (Danish Environmental Protection Agency (Denmark)). Teknologinaevnet, Copenhagen (Denmark). 1993. (CONF-9211286–Vol.1: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). In *Technology and democracy. Vol. 1: The use and impact of technology assessment in Europe. Proceedings.* 351p. Order Number DE94730319. Source: OSTI; NTIS.

This paper summarizes the Danish environmental policy focusing on cleaner technology. A report from the Danish minister for the Environment outlines the long term objectives of Danish environmental policy. Key-words of this policy are: prevention, use of market economy and taking precautionary actions. E.g. in administration of the new environmental policy Act specially attentions shall be given to promote cleaner technology. More than two hundred projects on development and implementation of cleaner technology have been launched according to two action plans. The results shows that major environment results can be achieved if coordinated actions on technological development are taken. Technologies that often are economically feasible for the private companies. By funding development projects the national authorities have major influence on the promotion of cleaner technologies. (au)

6787 (NEI-DK–1373-Vol.1, pp. 197-206) **Using technology assessment for the prevention of waste and emissions.** Vlist, J. van der (Deputy for Environmental Management and Energy, Province of South-Holland (Netherlands)). Teknologinaevnet, Copenhagen (Denmark). 1993. (CONF-9211286–Vol.1: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). In *Technology and democracy. Vol. 1: The use and impact of technology assessment in Europe. Proceedings.* 351p. Order Number DE94730319. Source: OSTI; NTIS.

Following a general outline of the environmental problems that face the Netherlands details are given of experiences gained from the PRISMA project. The project has shown that there are not enough opportunities open to Dutch trade and industry for them to become self-regulating. The government sees that the law is enforced and issues licences. Many industries see little incentive to reduce the amount of environmental pollution they cause. The Province of South-Holland has adopted some of the recommendations of the PRISMA project. A network is being set up of those departments which assist industries to integrate environmental protection in the management of their businesses. Staff charged with drawing up licences will have to become accustomed to the additional task of advising company management. Knowledge about the prevention of waste and emissions will need to be expanded. Companies will have to become accustomed to the new role of a government which originally only issued environmental licences. A certain amount of suspicion will need to be overcome. It is essential that we bring together all those who are delegated with an environmental task in order to enable current information exchange. Politicians will have to improve their evaluation of all aspects of environmental problems. Technology assessment can establish criteria for evaluating all kinds of pollution. (AB)

6788 (NEI-DK–1373-Vol.1, pp. 218-222) **Follow up to the PRISMA project from the perspective of the Netherlands National Environmental Centre.** Lever, H.M.D. Teknologinaevnet, Copenhagen (Denmark). 1993. (CONF-9211286–Vol.1: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). In *Technology and democracy. Vol. 1: The use and impact of technology assessment in Europe. Proceedings.* 351p. Order Number DE94730319. Source: OSTI; NTIS.

The follow-up by the Netherlands National Environmental Centre of the Dutch PRISMA project for stimulating industrial incentives to protect to environment is described. (AB)

6789 (NEI-DK–1373-Vol.2, pp. 569-587) **The integration of environmental issues in technology forecasting.** Hond, F. den (Free University - CAV, Amsterdam (Netherlands)). Teknologinaevnet, Copenhagen (Denmark). 1993. (CONF-9211286–Vol.2: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). In *Technology and democracy. Vol. 2: The use and impact of technology assessment in Europe. Proceedings.* 246p. Order Number DE94730320. Source: OSTI; NTIS.

Technology forecasting (TF) is a policy instrument to assist strategic decision making in technology policy. It has gained renewed attention in the Netherlands. A new topic in TF is to integrate environmental issues in TF. In this article I want to discuss the way in which environmental issues can be integrated into TF. In the first section the question will be discussed why policy makers have become interested in the integration of environmental issues in TF. For the Dutch Ministry of Economic Affairs, the business implications of emissions, waste, pollution, and public image of companies, are reasons for their interest. The Environmental Ministry is interested in the question because they see technology as both an opportunity and a threat to reach sustainability. The article has a conceptual character. It is based upon research work done for the Environmental Ministry, and upon an analysis of a recent TF by the Ministry of Economic Affairs. The main conceptual issues are discussed in section 2. This section also contains a comparison between the environmentally oriented technology forecasting (EDOTF) as we developed it, and the 'economic' TF of the Ministry of Economic Affairs. The third section discusses a number of problems that appeared in our attempt to integrate environmental issues in TF: assessment of the environmental impact, normative aspects, and the dynamic character of technology development. In the last sections conclusions are drawn and policy implications are discussed. (au) (27 refs.)

6790 (NEI-NO–383) **Impacts of climatic change on natural ecosystems with emphasis on boreal and arctic/alpine areas.** Holten, J.I.; Paulsen, G.; Oechel, W.C. (eds.). Norsk Inst. for Naturforskning, Trondheim (Norway); Direktoratet for Naturforvaltning, Trondheim (Norway). Feb 1993. 185p. (CONF-9011339–: Impact of climatic change on natural ecosystems, with emphasis on boreal and arctic/alpine areas, Trondheim (Norway), 27-29 Nov 1990). Order Number DE94730364. Source: OSTI; NTIS.

Separate abstracts were prepared for 4 papers of this conference.

6791 (NEI-NO–383, pp. 12-23) **An application of the Intergovernmental Panel on Climate Change's scientific assessment to northern ecosystems.** Callaghan, T.V. (Inst. of Terrestrial Ecology, Merlewood Research Station, Grange-over-Sands (United Kingdom)). Norsk Inst. for Naturforskning, Trondheim (Norway); Direktoratet for Naturforvaltning, Trondheim (Norway). Feb 1993. (CONF-9011339–: Impact of climatic change on natural ecosystems, with emphasis on boreal and arctic/alpine areas, Trondheim (Norway), 27-29 Nov 1990). In *Impacts of climatic change on natural ecosystems with emphasis on boreal and arctic/alpine areas.* 185p. Order Number DE94730364. Source: OSTI; NTIS.

Climatic change, an environmental problem of global proportions, has generated a global response. In 1988, the Intergovernmental Panel on Climate Change (IPCC) was jointly established by the World Meteorological Organization and the United Nations Environment Programme under the chairmanship of Dr. Bolin. It had a two-fold remit, (a) to assess the scientific information that is related to the various components of the climatic change issue, and that is needed to enable the environmental and socio-economic consequences of climatic change to be evaluated, and (b) to formulate realistic response strategies for the management of the climatic change issue. These objectives were attained by three working groups in 1990, only two years after the inauguration of IPCC. Perhaps the main messages of the Working Group 1 Report are that global mean surface air temperature has increased by 0.3°C to 0.6°C over the past 100 years with the five warmest years being in the 1980's. Over the same period, sea level has increased by 10 to 20 cm. These changes are consistent with predictions of climatic models which suggest further increases in temperature of about 0.3°C per decade and an increase in sea level of about 6 cm per decade. However, the unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more. 32 refs., 5 figs.

6792 (NEI-NO–383, pp. 24-38) **Biospheric feedback mechanisms to a changing climate in the North.** Callaghan, T.V. (Inst. of Terrestrial Ecology, Merlewood Research Station, Grange-over-Sands (United Kingdom)). Norsk Inst. for Naturforskning, Trondheim (Norway); Direktoratet for Naturforvaltning, Trondheim

(Norway). Feb 1993. (CONF-9011339–: Impact of climatic change on natural ecosystems, with emphasis on boreal and arctic/alpine areas, Trondheim (Norway), 27-29 Nov 1990). In *Impacts of climatic change on natural ecosystems with emphasis on boreal and arctic/alpine areas.* 185p. Order Number DE94730364. Source: OSTI; NTIS.

One of the major uncertainties in the formulation of the General Circulation Models, which are used to predict global warming, is the effect of feedback mechanisms. Although geophysical feedbacks are the most important feedbacks to climatic change, biogeochemical feedbacks are also significant with a suggested amplitude of +0.16. However, relatively little is known about the numerous and complex feedbacks involving the biosphere. Because of this complexity, the present paper introduces and discusses many of the biological mechanisms involved in the various types of biospheric feedbacks, but cannot quantify their effects at a global level. The main biospheric feedbacks involve the release of organically-derived methane from destabilized marine sediments and thawing permafrost and the reflectivity - or albedo - of the changing land and vegetation surface. Another important feedback is gas exchange from the biological processes of carbon dioxide draw-down in the photosynthesis of green plants and carbon emission to the atmosphere as either carbon dioxide from the aerobic respiration of soil micro-organisms or as methane from the anaerobic respiration of micro-organisms from waterlogged soils. There are many more feedbacks which are important, but the dynamic nature of the biological feedbacks through adaptation, evolution, species migrations and the many interactions between all biological processes, makes it extremely difficult to assess their overall directions and sizes. 75 refs., 5 figs., 2 tabs.

6793 (NEI-NO–383, pp. 136-150) **Forecasting the impact of climatic change on natural vegetation with particular reference to the boreal and sub-arctic floras.** Hendry, G.A.F. (NERC, Unit of Comparative Plant Ecology, Dept. of Animal and Plant Sciences, Sheffield Univ. (United Kingdom)). Norsk Inst. for Naturforskning, Trondheim (Norway); Direktoratet for Naturforvaltning, Trondheim (Norway). Feb 1993. (CONF-9011339–: Impact of climatic change on natural ecosystems, with emphasis on boreal and arctic/alpine areas, Trondheim (Norway), 27-29 Nov 1990). In *Impacts of climatic change on natural ecosystems with emphasis on boreal and arctic/alpine areas.* 185p. Order Number DE94730364. Source: OSTI; NTIS.

Species richness, together with temperature, decreases with increasing latitude. In the event of prolonged climate warming, plant species from lower latitudes and altitudes will expand into former colder areas. Limitations to successful invasions include the need for long-distance transport of propagules, germination and development under fundamentally different photoperiods and rapid development of mycorrhiza adapted to the invading species. Increases in atmospheric CO_2 are likely to disturb long-established relations between species distribution and temperature, moisture and nutrient availability. Certain identified communities will be displaced and in Britain the already protected remnants of the boreal and arctic floras appear particularly vulnerable. Changing patterns of land use in marginal hill-farming areas will increase the rate of displacement of long-established communities. With warming, given adequate rainfall and access to suitable habitats, other species, including a significant proportion of the rare and protected orchid flora of Britain will expand territorially. The experimental basis and underlying mechanisms for these predictions are described. 37 refs., 11 figs., 7 tabs.

6794 (PNL–8950) **Staff exchange with Chemical Waste Management: Final project report.** Harrer, B.J.; Barak, D.W. Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 82p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004754. Source: OSTI; NTIS; GPO Dep.

Original objective was transfer of PNL technology and expertise in computational chemistry and waste flow/treatment modeling to CWM. Identification and characterization of a broader portfolio of PNL's environmental remediation technologies with high potential for rapid application became the focus of the exchange, which included E-mail exchanges. Of the 14 technologies discussed, the following were identified as being of high interest to CWM: six phase soil heating (in-situ heating), high energy electrical corona, RAAS/ReOpt™ (remedial, expert system), TEES™ (catalytic production of methane from biological wastes), PST (process for treating petroleum sludge). CWM's reorganization and downsizing reduced the potential benefits to industry, but a proposal for transfer and application of PST to Wheelabrator was made.

2904 Energy Resources

Refer also to citation(s) 6768

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 6080, 6785, 6789, 6824, 6830, 6881, 6882, 6912, 6961

6795 (DOE/LM–0001) **US Department of Energy multiprogram laboratories, 1981 to 1991, a decade of change.** USDOE Office of Lab. Management, Washington, DC (United States). Apr 1993. 38p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003860. Source: OSTI; NTIS; GPO Dep.

The U.S. Department of Energy's multiprogram laboratories were conceived as a means of enlisting private enterprise and managerial skills to develop atomic weapons during World War II. Today these laboratories perform research and development in a host of areas critical to the U.S. Research and development areas incorporated within their missions include: technologies for maintaining national security; the fundamental nature of matter and energy processes; environmental processes; energy production technologies; and energy conserving technologies. This document identifies the laboratories and describes historical trends, laboratory projections, individual laboratory profiles, and laboratory organization and oversight for the multiprogram system.

6796 (IVA-M–277) **Energy for generations to come. Energy research 1975-1992: Part 1. Governmental investments, ambitions and results.** Royal Swedish Academy of Engineering Sciences, Stockholm (Sweden). 1992. 63p. (In Swedish). Order Number DE94730426. Source: OSTI; NTIS.

The Swedish government founded research program was initiated in 1975 as a response to the oil crisis. In total, 17 billion SEK has been spent (1975 - July 1993), with max yearly allocation in the beginning of the 80s. Today universities receive about 50 percent of the grant and industry 30 percent - roughly a reverse of the situation at the start of the program. The objectives and results of the program are analyzed in this volume. It is noted that the programs for efficient energy use have been successful, whereas the thermal solar energy and the alternative fuels programs never made any commercial impacts. Research administration and the different actors in the programs are also treated. 21 refs, 6 figs, 8 tabs

6797 (LBL-PUB–5375) **Lawrence Berkeley Laboratory, Institutional Plan FY 1994–1999.** Lawrence Berkeley Lab., CA (United States). Sep 1993. 187p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94003453. Source: OSTI; NTIS; GPO Dep.

The Institutional Plan provides an overview of the Lawrence Berkeley Laboratory mission, strategic plan, scientific initiatives, research programs, environment and safety program plans, educational and technology transfer efforts, human resources, and facilities needs. For FY 1994-1999 the Institutional Plan reflects significant revisions based on the Laboratory's strategic planning process. The Strategic Plan section identifies long-range conditions that will influence the Laboratory, as well as potential research trends and management implications. The Initiatives section identifies potential new research programs that represent major long-term opportunities for the Laboratory, and the resources required for their implementation. The Scientific and Technical Programs section summarizes current programs and potential changes in research program activity. The Environment, Safety, and Health section describes the management systems and programs underway at the Laboratory to protect the environment, the public, and the employees. The Technology Transfer and Education programs

section describes current and planned programs to enhance the nation's scientific literacy and human infrastructure and to improve economic competitiveness. The Human Resources section identifies LBL staff diversity and development program. The section on Site and Facilities discusses resources required to sustain and improve the physical plant and its equipment. The new section on Information Resources reflects the importance of computing and communication resources to the Laboratory. The Resource Projections are estimates of required budgetary authority for the Laboratory's ongoing research programs. The Institutional Plan is a management report for integration with the Department of Energy's strategic planning activities, developed through an annual planning process.

6798 (NEI-DK–1373-Vol.1) **Technology and democracy. Vol. 1: The use and impact of technology assessment in Europe.** Teknologinaevnet, Copenhagen (Denmark). 1993. 351p. (CONF-9211286–Vol.1: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). Order Number DE94730319. Source: OSTI; NTIS.

A major theme of the Third European Congress on Technology Assessment, "Technology and Democracy" was related to the question of how technology assessment may assist in the creation of a better foundation for decision-making when new technologies are introduced. The discussion, which involved politicians, researchers and representatives from industry, trade unions and various interest groups, focussed on how technology assessment can facilitate the creation of a dialogue between the parties involved in the decision-making processes. The Congress concluded in general, that as a result of the increasing complexity of our societies, the need for technology assessment to create the necessary multidimensional foundation for decision-making becomes more and more urgent. Such decisions will chose technologies with built-in opportunities and reduced risk factors. It was stated, that ordinary people, if adequately informed, are able to form opinions on this. The involvement of citizens and the opening of a democratic debate put limits on the use of technology and heightens its acceptability, which result, in an improvement of its quality and productivity. Technology assessment cases from all over Europe were presented. The workshop conclusions are included in Volume I. Volume II includes the papers from the Post-Congress workshop, "Methods in Technology Assessment and Decision-Making" and the conclusions from the Post-Congress workshop. (AB)

6799 (NEI-DK–1373-Vol.2) **Technology and democracy. Vol. 2: The use and impact of technology assessment in Europe.** Teknologinaevnet, Copenhagen (Denmark). 1993. 246p. (CONF-9211286–Vol.2: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). Order Number DE94730320. Source: OSTI; NTIS.

A major theme of the Third European Congress on Technology assessment, "Technology and Democracy" was related to the question of how technology assessment may assist in the creation of a better foundation for decision-making when new technologies are introduced. The discussion, which involved politicians, researchers and representatives from industry, trade unions and various interest groups, focussed on how technology assessment can facilitate the creation of a dialogue between the parties involved in the decision-making processes. The Congress concluded in general, that as a result of the increasing complexity of our societies, the need for technology assessment to create the necessary multidimensional foundation for decision-making becomes more and more urgent. Such decisions will choose technologies with built-in opportunities and reduced risk factors. It was stated that ordinary people, if adequately informed, are able to form opinions on this. The involvement of citizens and the opening of a democratic debate put limits on the use of technology and heightens its acceptability, which results in an improvement of its quality and productivity. Technology assessment cases from all over Europe were presented. The workshop conclusions are included in Volume I. Volume II includes the papers form the Post-Congress workshop, "Methods in Technology Assessment and Decision-making" and the conclusions from the Post-Congress Workshop. (AB)

6800 (NEI-DK–1373-Vol.2, pp. 365-389) **Decision aid in R and D for an environmental compatible production.** Hirtz, G.W. (Reserch Centre Juelich GmbH, Systemes Analyses and Technology Evaluation (Germany)); Huber, W. Teknologinaevnet, Copenhagen (Denmark). 1993. (CONF-9211286–Vol.2: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). In *Technology and democracy. Vol. 2: The use and impact of technology assessment in Europe. Proceedings.* 246p. Order Number DE94730320. Source: OSTI; NTIS.

The project implemented on behalf of the Federal Ministry for Research and Technology (BMFT) since early 1990 has the objective of developing a test procedure to ensure that the impacts on man and the environment of a technological development planned by a research project can be revealed in good time. The decisions makers will thus be in a position to decide at the earliest possible point, before or after approving research projects, which of the various environmental aspects are to be regarded for the projects and should be integrated into the projects as goals or criteria. In the orientation phase of the multistage test procedure the investigation framework is laid down via the stages of material identification, estimate of environmental significance, and analyses of material flows. In the implementation and assessment phase the EPS (The test procedure mentioned above) is carried out on a project-internal basis according to particular specifications before or in parallel to the project. In the postexamination phase the target is examined and new insights form the EPS and the project itself are included in the test process and may if necessary initiate a renewed EPS. (au) (13 refs.)

6801 (NEI-DK–1373-Vol.2, pp. 409-431) **The integration of technology assessment into research programs: A tool for early warning and inexpensive minimisation of serious failures in the steering of technological developments.** Hohmeyer, O. (Fraunhofer-Institut for Systems and Innovation Research, Karlsruhe (Germany)); Huesing, B.; Reiss, T. Teknologinaevnet, Copenhagen (Denmark). 1993. (CONF-9211286–Vol.2: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). In *Technology and democracy. Vol. 2: The use and impact of technology assessment in Europe. Proceedings.* [246p.] Order Number DE94730320. Source: OSTI; NTIS.

In order to minimize the costs of failures in technology development, possible negative implications of a widespread use of new technologies, which could render these unacceptable to the general public, need to be identified before substantial sums of money are invested in their development and production. While the changes of getting early warning signals of such implications from technology assessments (TA) increase with an early start of the assessment during the research and development process, the cost of getting reliable signals from TA is considerably higher during very early stages of technology development as compared to the analysis of relatively mature technologies. The authors suggest a stepwise approach of technology assessment including advanced methods for monitoring technological change integrated into the actual research and development process. Based on the example of the ongoing technology assessment on 'Biological Hydrogen Production' it is shown how such an integrated approach can be implemented and which results can be reached. (au)

6802 (NEI-SE–131) **Research and development. Forward look and proposals for 1993-96.** Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1993. 44p. Order Number DE94730424. Source: OSTI; NTIS.

The Swedish National Board for Industrial and Technical Development (NUTEK) is a government agency handling issues concerning the growth and innovation of industry and the reorientation of the energy system. NUTEKs primary activities are oriented towards implementation of the governments industrial policy in such fields as technical research and industrial development, promotion of new and existing enterprises, regional development, safe and environment-friendly energy supply and more efficient use of energy. The present publication summarizes NUTEKs proposals concerning technical R and D and energy research for the three-year period starting July 1, 1993. It also provides and insight into NUTEKs work in this R and D area as well as into current technical-industrial developments in Sweden. The original Swedish version is entitled, Research Collaboration for Renewal of Industry and energy Systems and comprises 144 pages, which means that

several passages have been omitted or abridged in composing the present publication. 14 figs

2906 Nuclear Energy

Refer also to citation(s) 6639

6803 (BfS-KT–5/93-REV-1) **Status and development of nuclear energy utilization in the Federal Republic of Germany - as of May 1993.** Philippczyk, F.; Ziegenhagen, J. Bundesamt fuer Strahlenschutz, Salzgitter (Germany). Fachbereich Kerntechnische Sicherheit. Jul 1993. 51p. (In German). Order Number DE94734093. Source: OSTI; NTIS (US Sales Only); INIS.

The report states the essential data of all nuclear power plants, the facilities of the nuclear fuel cycle and the storage of radioactive wastes. In 1992, 20 nuclear power plants were in operation. With 158.840 GWh altogether they provided 34% of the total gross electricity production. The report summarizes the essential operational results of the nuclear power plants as well as the use of mixed oxide fuel elements (MOX). A short description of the present state of the nuclear power plants that have been shut down or decommissioned and of the stopped programmes is given. Data on purpose and capacity of facilities of the nuclear fuel cycle and of radioactive waste storage are given. Furthermore, the licensing history and the present state of operation and licensing are represented. Three projects with regard to disposal of radioactive wastes are presented according to their present state. To give a survey, the data are summarized in tabular form in the report annexes. (orig.)

6804 (PNL-SA–21958) **Team Hanford: Records management in a multi-contractor environment.** Anderson, E.N. (Pacific Northwest Lab., Richland, WA (United States)); Anderson, T.V.; Munch, J.W.; Potter, C.N. Pacific Northwest Lab., Richland, WA (United States). Aug 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9308110–2: 17. annual symposium of the Nuclear Information and Records Management Association, Augusta, GA (United States), 29 Aug - 2 sep 1993). Order Number DE94004360. Source: OSTI; NTIS; GPO Dep.

Expanding technology, increased emphasis on cost containment, and an ever growing list of requirements and regulations present challenges to records managers. The multi-contractor environment of the Department of Energy's (DOE) Hanford Site further complicates the picture. In an effort to strengthen the site's records management program, representatives of DOE's Richland Operations Office and its four Hanford contractors joined forces. This synergistic Team Hanford approach continues to spawn success and is looked on as a model for similar DOE sites.

2908 Heat Utilization

Refer also to citation(s) 6901

6805 (KFK–5126) **The role of combined heat and power (CHP) in energy and climate policy.** Conrad, F. Kernforschungszentrum Karlsruhe GmbH (Germany). Abt. fuer Angewandte Systemanalyse. Mar 1993. 103p. (In German). Order Number DE94734101. Source: OSTI; NTIS (US Sales Only); INIS.

In the energy- and environment context CHP is said to be especially energy saving and climate preserving. This report shows that from the standpoint of energy economics as well as under technical aspects this judgement holds true only under special conditions. Depending on the technical parameters, the concrete circumstances of operation and the characteristics of the power plants and heating systems compared to CHP-plants the range of realistic energy savings turns out to be very large. Related overstimations are to a good extend caused by the traditional practice of granting the energetic advantage of CHP exclusively to the district heating. If this advantage is credited to heat and power as equal shares space heating with cogenerated power of 80% efficiency reveals to be very energy conserving. The uno actu utilization of cogenerated heat and power, for the same purpose could facilitate the expansion of CHP, since the problems related to the feeding of cogenerated power into the grid for general purposes would disappear. The second main issue of this report concerns the abatement of CO_2-emissions with the aid of CHP. Fuelled with natural gas, CHP-plants are attractive instruments for climate policy. This is especially true if CHP is compared to old coal-based power plants and oil-fuelled old heating systems. In the FRG, however, hard coal, and not natural gas, will be the main fuel for future CHP, lowering its CO_2-advantage considerably. On the other hand high efficient combi-power plants (gas turbine plus condensing turbine) and gas heating systems have to be included in the comparative analyse. Compared to these advanced systems the CO_2-characteristics of CHP are inferior. Moreover, the specific CO_2-advantage of natural gas is better used by such modern mono systems rather than CHP-plants. (orig.)

6806 (NEI-DK–1368, pp. 5-9) **Development of Danish district heating.** Petersen, E. (Danish District Heating Association (Denmark)). Energistyrelsen, Copenhagen (Denmark). 1993. In *District heating in Denmark: Research and technological development.* 56p. Order Number DE94730318. Source: OSTI; NTIS.

The historical aspects of the development of district heating and cogeneration plants in Denmark are briefly summarized. Statistical data on the number of Danish district heating plants and their production are presented. Maps illustrate the geographical distribution of district heating plants in Denmark and the fuels they use. The structure and activities of three Danish district heating organizations are described. (AB)

6807 (NEI-DK–1368, pp. 47-49) **Economy and organisation.** Randloev, P. (Ramboell, Hannemann og Hoejlund A/S (Denmark)); Dyrelund, A. Energistyrelsen, Copenhagen (Denmark). 1993. In *District heating in Denmark: Research and technological development.* 56p. Order Number DE94730318. Source: OSTI; NTIS.

The economy and organization of Danish district heating is concisely described and illustrated by graphs. (AB)

6808 (NEI-DK–1368, pp. 50-52) **New developments and future technologies.** Boehm, B. (Centre for District Heating Technology, Technical University of Denmark (Denmark)). Energistyrelsen, Copenhagen (Denmark). 1993. In *District heating in Denmark: Research and technological development.* 56p. Order Number DE94730318. Source: OSTI; NTIS.

New developments and future technologies in relation to Danish district heating systems are shortly described. Supply temperatures and transport time are illustrated by graphs and a map of an urban area indicates the location of heat exchangers in the heat distribution network. Operational optimization is discussed in addition to research programmes, house stations and heat meters. (AB)

2910 Conservation

Refer also to citation(s) 6820

6809 (NEI-DK–1353) **Issues and options in the energy sector in Latvia. Vol. 1: Background reports. Energy conservation in Latvia. Energy utilities and pricing.** PA Consulting Group A/S, Lyngby (Denmark). 1993. 51p. Contract IMOe-425. Order Number DE94730158. Source: OSTI; NTIS.

This report present two background reports to the project "Issues and options analysis for rational energy management in Latvia" managed by PA Consulting Group. The background reports deals with energy conservation in Latvia and issues and options analysis for rational energy management in Latvia. (CLS)

6810 (NREL/TP–461-5478) **Energy-efficient mortgages and home energy rating systems: A report on the nation's progress.** Farhar, B.C.; Eckert, J. National Renewable Energy Lab., Golden, CO (United States). Sep 1993. 282p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE93018230. Source: OSTI; NTIS; GPO Dep.

This report summarizes progress throughout the nation in establishing voluntary programs linking home energy rating systems (HERS) and energy-efficient mortgages (EEMs). These programs use methods for rating the energy efficiency of new and existing homes and predicting energy cost savings so lenders can factor in energy cost savings when underwriting mortgages. The programs

also encourage lenders to finance cost-effective energy-efficiency improvements to existing homes with low-interest mortgages or other instruments. The money saved on utility bills over the long term can more than offset the cost of such energy-efficiency improvements. The National Collaborative on HERS and EEMs recommended that this report be prepared.

6811 (ORNL/FTR–4852) **Travel to the Netherlands for IEA's meeting for the analysis and dissemination of demonstrated energy technology: Foreign trip report, November 13–20, 1993.** Broders, M.A. Oak Ridge National Lab., TN (United States). 24 Nov 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004465. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The traveler, serving as delegate from the United States Center for the Analysis and Dissemination of Demonstrated Energy Technology Energy Efficiency National Team, participated in the activities of the annual International Energy Agency's Center for the Analysis and Dissemination of Demonstrated Energy Technology Annex I–Energy Efficiency National Team working meeting. Highlights of this meeting included introduction of Version 4.0 of the Center's newly designed Register and associated data base management system, and development of the Center's 1994 Work Program which defines future analysis topics, newsletter topics, brochure production, and register input. The traveler also participated as an observer in the activities of the first annual meeting of the International Energy Agency's Center for the Analysis and Dissemination of Demonstrated Energy Technology Annex II–Renewable Energy National Team working meeting.

6812 (PNL-SA–22175) **Impact evaluations in the industrial sector: Case studies and findings.** Spanner, G.E. (Pacific Northwest Lab., Richland, WA (United States)); Brown, D.R.; Riewer, S. Pacific Northwest Lab., Richland, WA (United States). Aug 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930842–4: 6. international conference on energy program evaluation: uses, methods and results, Chicago, IL (United States), 23-27 Aug 1993). Order Number DE94004364. Source: OSTI; NTIS; GPO Dep.

To meet the increasing demand for energy at reasonable cost, while minimizing the effects of energy production on the environment, the Pacific Northwest will actively pursue energy conservation as a source of energy. Bonneville Power Administration's (Bonneville's) goal is to save 660 average megawatts (aMW) by the year 2000 as its share of the Northwest conservation goal. Bonneville recognizes that a potential source of significant energy conservation is the industrial sector. Accordingly, in 1987, Bonneville began offering the Energy $avings Plan (E$P) Program to obtain electrical energy conservation in this sector. Combined annual savings for all of the completed projects to date total over 104 million kilowatt-hours (kWh) per year. In terms of capacity, the program is saving about 11.9 aMW thus far. To date, the program has made acquisition payments totalling $3,853,800 to 55 participants. The total installed cost of the projects is $38,178,100. The average project is saving 1,892,300 kWh/yr (1,482,900 kWh/yr excluding the largest project which saves 24,000,000 kWh/yr).

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 6099, 6100, 6773, 6841

6813 (DOE/EIA–0202(93/4Q)) **Short-Term Energy Outlook: Quarterly projections: Fourth quarter 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. 5 Nov 1993. 38p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94002854. Source: OSTI; NTIS; GPO; GPO Dep.

The Energy Information Administration (EIA) prepares quarterly, short-term energy supply, demand, and price projections for publication in February, May, August, and November in the Short-Term Energy Outlook (Outlook). An annual supplement analyzes the performance of previous forecasts, compares recent cases with those of other forecasting services, and discusses current topics related to the short-term energy markets. (See Short-Term Energy Outlook Annual Supplement, DOE/EIA-0202.) The forecast period for this issue of the Outlook extends from the fourth quarter of 1993 through the fourth quarter of 1994. Values for the third quarter of 1993, however, are preliminary EIA estimates (for example, some monthly values for petroleum supply and disposition are derived in part from weekly data reported in the Weekly Petroleum Status Report) or are calculated from model simulations using the latest exogenous information available (for example, electricity sales and generation are simulated using actual weather data). The historical energy data are EIA data published in the Monthly Energy Review, Petroleum Supply Monthly, and other EIA publications.

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 6765, 6774, 6776, 6780, 6790, 6791

6814 (NEI-DK–1371) **Investigation of the energy sector: Structure, energy taxes and competition conditions.** Konkurrenceraadet, Copenhagen (Denmark). 1993. 196p. (In Danish). Order Number DE94730328. Source: OSTI; NTIS.

The (Danish) Competition Council has emphasized that energy taxes comprise a significant part of the overall costs of industrial firms in Denmark and that working towards the goals of Danish energy policy has a strong influence on competition between companies. Governmental control of supply and demand through the use of taxation, subsidies and planning stipulations has resulted in a weakening of the market mechanism's steering of energy consumption towards optimal efficiency. The main aim of the statement is to describe Danish energy supply and the distortion of conditions of competition that can be found within the part of the Danish energy sector which deals with public supply of electricity and heating and individual supply of fuels for heating purposes. The Danish law on competition is elaborated. The Council suggests that the current combination of energy and environmental interests can not be realised within a system which builds totally on market premisses but that these political goals could only be achieved within a simpler, more logical system which will allow incitaments to competition and continued increase of effectivity and thus a better compatibility with market mechanisms. The conclusions of the evaluation by The Competition Council are presented in detail and concern the market structure, the powerful governmental control, market access, price setting, the element of force, EU initiatives and taxes on energy and carbon dioxide emission. Historical aspects of this subject are also described. Comments from three concerned Danish organizations on the statement are included in the publication. (AB)

6815 (ORNL/M–3027) **Coastal Zone Management Act and related legislation: Revision 3: Environmental Guidance Program Reference Book.** Oak Ridge National Lab., TN (United States). 15 Oct 1993. 135p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004180. Source: OSTI; NTIS; GPO Dep.

In recognition of the increasing pressures upon the nation's coastal resources, Congress enacted the Coastal Zone Management Act in 1972. Its purpose is to encourage states to preserve, protect, develop, and, where possible, restore or enhance such valuable natural resources as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife utilizing those habitats. A unique feature of the Act is that participation by states is voluntary. One key provision for encouraging states to participate is the availability of federal financial assistance to any coastal state or territory, including those on the Great Lakes, which is willing to develop and implement a comprehensive coastal management program. Additionally, the Coastal Barrier Resources Act (CBRA) was passed in 1983. This report contains the legislative history and statues associated with each Act. Regulations for implementation and other guidance are included.

6816 (PNL-SA–22894) **An object-oriented approach to energy-economic modeling.** Wise, M.A.; Fox, J.A.; Sands, R.D. Pacific Northwest Lab., Richland, WA (United States). [1993]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9310234–2: International Association for Energy Economics North American conference,

Seattle, WA (United States), 11-13 Oct 1993). Order Number DE94003720. Source: OSTI; NTIS; GPO Dep.

In this paper, the authors discuss the experiences in creating an object-oriented economic model of the U.S. energy and agriculture markets. After a discussion of some central concepts, they provide an overview of the model, focusing on the methodology of designing an object-oriented class hierarchy specification based on standard microeconomic production functions. The evolution of the model from the class definition stage to programming it in C++, a standard object-oriented programming language, will be detailed. The authors then discuss the main differences between writing the object-oriented program versus a procedure-oriented program of the same model. Finally, they conclude with a discussion of the advantages and limitations of the object-oriented approach based on the experience in building energy-economic models with procedure-oriented approaches and languages.

2940 Fossil Fuels

Refer also to citation(s) 6080, 6099, 6100, 6770, 6813, 6823, 6919

6817 (CMR–92-A30013) **Petroleum tax systems and risk sharing.** Sunnevaag, K. Christian Michelsen Research A/S, Bergen (Norway). Dec 1992. 25p. Order Number DE94730368. Source: OSTI; NTIS; INIS.

We have focused on four different measures of risk, well known from the finance literature, namely sensitivity, standard deviation, coefficient of variation and finally probability of a negative expected net present value (NPV). While the two first measures show that the state carries most of the risk, the latter measures show the opposite result. Whether or not the project is developed on a stand-alone or on-going basis, has a crucial impact on much risk the company carries. We have also looked at the risk development as a consequence of changes in tax regime. While the two first measures of risk (sensitivity and standard deviation) show an increase in risk for the company from the pre 1987 tax regime to the 1987-1991 tax regime, and a decrease in risk as a consequence of the last change, the opposite is the case when we look at the two last measures of risk, namely coefficient of variation and probability of a negative expected NPV. The same is the conclusion for the state, except that the sign of change is the opposite that of the company. This analysis could have been extended to include a risk concept based on the well known Capital Asset Pricing Model, which is relevant risk, or covariance risk. This model concludes that the return on any risky asset is a function of the correlation between the return on this asset and the market portfolio. In this case only the projects contribution to the portfolio risk should be accounted for. For the Norwegian state it is not unreasonable to assume that the risk contribution of a medium sized oil field to a big portfolio of fields and onshore activities only is marginal. For the national or international oil company it is somewhat less marginal, and for a company developing the field on a stand-alone basis it is substantial. 12 refs., 15 figs.

6818 (DOE/EIA–0370(93)) **Oil and gas field code master list, 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 16 Dec 1993. 447p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004648. Source: OSTI; NTIS; GPO; GPO Dep.

This document contains data collected through October 1993 and provides standardized field name spellings and codes for all identified oil and/or gas fields in the United States. Other Federal and State government agencies, as well as industry, use the EIA Oil and Gas Field Code Master List as the standard for field identification. A machine-readable version of the Oil and Gas Field Code Master List is available from the National Technical Information Service.

6819 (DOE/EIA–0571) **Energy Policy Act transportation rate study: Availability of data and studies.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. 13 Oct 1993. 70p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94002309. Source: OSTI; NTIS; GPO; GPO Dep.

Pursuant to Section 1340(c) of the Energy Policy Act of 1992 (EPACT), this report presents the Secretary of Energy's review of data collected by the Federal Government on rates for rail and pipeline transportation of domestic coal, oil, and gas for the years 1988 through 1997, and proposals to develop an adequate data base for each of the fuels, based on the data availability review. This report also presents the Energy Information Administration's findings regarding the extent to which any Federal agency is studying the impacts of the Clean Air Act Amendments of 1990 (CAAA90) and other Federal policies on the transportation rates and distribution patterns of domestic coal, oil, and gas.

6820 (NEDO-P–9205) **Present situation of petroleum substitution energy development (East Europe).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 45p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE94732335. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

A survey is made to grasp trends of the petroleum substitution energy development in East European countries. The development of petroleum substitution energy has been an important issue pertaining to independence and security of those countries since they were dependent on crude oil imports from the former USSR and domestically produced low-grade coal under the former COMECON regime. After the dissolution of COMECON, they are shifting supply of a considerable amount of electric power to supply from areas other than the former USSR. On the other hand, the strengthening of domestic coal-fueled power generation is difficult in terms of funds and the environment. Accordingly, there is no possibility of their getting easily out of the fragile structure characterized by dependence on electric power imports. In a state of chaos amid transition to the market economy, expenses for development of petroleum subsitution energy cannot be prepared under the actual circumstances. Therefore, needs for conserving energy have been aware of and the activities have been developed as seen in an energy conservation fund established in Porland in 1992. Energy mass consumption has been increased with fuel prices artificially kept low since under the old political system, and now improvement of economic efficiency through energy conservation and environmental protection are beginning to be recognized. 3 figs., 15 tabs.

6821 (NEI-DK–1368, pp. 14-17) **District heating: A clean solution.** Hansen, L. (dk-TEKNIK (Denmark)). Energistyrelsen, Copenhagen (Denmark). 1993. In *District heating in Denmark: Research and technological development.* 56p. Order Number DE94730318. Source: OSTI; NTIS.

The environmental risks and uncertainties of a high-energy future are disturbing and give rise to several reservations concerning the use of fossil fuels. A number of technologies will help to reduce atmospheric pollution. In Denmark special importance is attached to the following: Energy conservation. Efficient energy conversion. Renewable energy sources. District heating, combined production of heat and power. Many agree that district heating (DH), produced by the traditional heat-only plant, and combined heat and power (CHP) have enormous potential when considering thermal efficiency and lowered environmental impacts: The basic technology of each is proven, it would be relatively simple to satisfy a substantial part of the energy demand, and their high efficiencies mean reduced pollution including greenhouse gas emissions. This is especially important in high population density areas - the obviously preferred sites for such energy generation. Compared with individual heating DH can provide a community with an operationally efficient and most often also an economically competitive heat supply. This is particularly true under the circumstances where the DH system is supplied from CHP plants. Their use results in very substantial improvements in overall efficiency. Further environmental improvements arise from the reduced air pollution obtainable in reasonably large CHP plants equipped with flue gas cleaning to remove particles, sulphur dioxide, and nitrogen acids. As a consequence of these considerations, DH plays an important role in fulfilling the space and water heating demand in many countries. This is especially the case in Denmark where this technology is

utilised to a very great extent. Indeed, DH is one of the reasons why Denmark has relatively good air quality in the cities. (au)

2950 Hydrogen and Synthetic Fuels

Refer also to citation(s) 6917

6822 (NREL/CP–200-5768-Vol.2, pp. 876-890) **National SoyDiesel Development Board standards for biodiesel.** Holmberg, W.C. (American Biofuels Association, Washington, DC (United States)); Gavett, E.E.; Merrill, P.N.; Peeples, J.E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Biodiesel (esters derived from vegetable oils and animal fats) has a promising future in the United States. Recent environmental and energy legislation has opened the market for this clean burning, non-toxic, biodegradable fuel. However, this same legislation controls access to that market, requiring extensive testing and demonstrations to verify "equal to or better than" performance and emission reductions compared to "clean diesel." To an extent unknown in the past, legal requirements, as well as technical specifications, are a determining factor in setting fuel standards. Although Biodiesel has technical hurdles to be overcome in satisfying existing and upcoming alternative and clean fuel regulations, it appears that these impediments are relatively minor. The National SoyDiesel Development Board (NSDB) is funding the engine and fuel testing necessary to achieve US Environmental Protection Agency (EPA) recognition as a cleaner-burning fuel. In addition, the NSDB is also working closely with other feedstock producers, engine manufacturers and governmental agencies on development of fuel standards for Biodiesel. Further, the American Biofuels Association (ABA) is working with the Clinton Administration and Congress to gain incentives for Biodiesel similar to those already available for other biofuels. Through this cooperative effort, Biodiesel is expected to become a viable motor fuel component in the US within the next few years.

2960 Electric Power

Refer also to citation(s) 6568, 6753, 6756, 6757, 6762, 6770, 6813, 7385

6823 (DOE/EIA–0226(93/12)) **Electric power monthly, December 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. 20 Dec 1993. 191p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004469. Source: OSTI; NTIS; GPO; GPO Dep.

This publication provides monthly statistics at the US Census division, and State levels for net generation, fossil fuel consumption and stocks, quantity and quality of fossil fuels, cost of fossil fuels, electricity sales, revenue, and average revenue per kilowatthour of electricity sold. Data on net generation, fuel consumption, fuel stocks, quantity and cost of fossil fuels are also displayed for the North American Electric Reliability Council (NERC) regions. Statistics by company and plant are published in the EPM on the capability of new generating units, net generation, fuel consumption, fuel stocks, quantity and quality of fuel, and cost of fossil fuels.

6824 (DOE/FTR–93016208) **Travel to Thailand to explore US electric industry services: Foreign trip report, May 13–20, 1992.** USDOE, Washington, DC (United States). [1992]. 15p. Sponsored by USDOE, Washington, DC (United States). Order Number DE93016208. Source: OSTI; NTIS (US Sales Only); GPO Dep.

A team of US experts on electric power technologies visited Thailand, May 13–20, 1992 to meet with officials from Thailand's three electric utilities. The team discussed the utilities' plans for expanding and upgrading their production, transmission and distribution facilities and provided information on US technologies that are available to meet the utilities' needs. The purpose of the mission was to obtain information needed to prepare a report on opportunities for US electric power industry goods and services in Thailand. Thailand was selected because: (1) it has substantial economic growth and faces sustained and substantial increases in demand for electricity; (2) prospects for funding electric power projects were considered good; (3) Thailand's utilities are reasonably well managed with the support of stable government policies, and (4) Thailand can be expected to provide a "level playing field" for US suppliers. It was also felt that any lessons learned would provide insight into possible problems/opportunities US firms might face in other Asian markets. The overriding general conclusion of the team is that the US electric power industry does not have the kind of extensive links with their Thai counterparts that our competitors have. This ranges from participation in professional organizations to technical support for the individual utilities. For example, the team learned that Thai utility officials to not attend IEEE meetings in the US because IEEE does not allow organizations to join. The Thai Government will only support their attendance at meetings of organizations in which the utilities are members. Thus, EGAT, PEA, and MEA are more active in SEGRAY, and other organizations that are European based.

6825 (NEI-DK–1353, [pp. 18]) **Issues and options analysis for rational energy management in Latvia.** Skaarup, J. (NESA A/S (Denmark)). PA Consulting Group A/S, Lyngby (Denmark). 1993. Contract IMOe-425. In *Issues and options in the energy sector in Latvia. Vol. 1: Background reports. Energy conservation in Latvia. Energy utilities and pricing.* 51p. Order Number DE94730158. Source: OSTI; NTIS.

This report is prepared as part of the project "Issues and options analysis for rational energy management in Latvia" under the guidance of PA Consulting Group, and it is to be seen as a background report to the main report of the project. In all essentials, the report is based on interviews, etc. during a stay in Riga in the period from 5 September 1992 to 19 September 1992, and it contributes to illustrate the following main areas: Institutional structure in the power sector. Tariff structure and policy. Latvenergo's potential for providing advisory service on electricity savings. Power sector statistics. (au)

6826 (NEI-DK–1354) **Situation analysis for integrated resource planning in the Danish electric utilities.** ELKRAFT A.m.b.A., Ballerup (Denmark). Apr 1993. 70p. Order Number DE94730214. Source: OSTI; NTIS.

The project covers the entire Danish electric industry, power supply and distribution of electricity, in the eastern as well as western part of Denmark. The concept Least Cost Planning (LCP) emerged in the USA in the mid-seventies and has been extended so as to cover Integrated Resource Planning (IRP), as well as peak load management, energy savings and other demand-side options (Demand Side Management, DSM). The background for LCP in the USA was the first energy crisis and later difficulties related to the construction of new power plants, etc. In USA, IRP and DSM are traditionally linked. Integrated Resource planning aims at providing energy services at the least cost within a given strategic framework. A principal objective in the Danish IRP project is to create a learning process which will ensure the continuous development of professional skill and also create a "common language". Another objective is to develope a planning tool to support constructive work on achieving electricity conservation and load management, DSM. As a consequence, knowledge of cost-related aspects of supply-side and demand-side options are being established and also methods for the control of greenhouse gases, especially CO_2. (AB)

6827 (PNL-SA–23064) **Iterative methods for the WLS state estimation on RISC, vector, and parallel computers.** Nieplocha, J. (Pacific Northwest Lab., Richland, WA (United States)); Carroll, C.C. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC06-76RL01830. Grant ECS-8907742. (CONF-9310246–1: 1993 North American power symposium, Washington, DC (United States), 11-12 Oct 1993). Order Number DE94004260. Source: OSTI; NTIS; GPO Dep.

We investigate the suitability and effectiveness of iterative methods for solving the weighted-least-square (WLS) state estimation problem on RISC, vector, and parallel processors. Several of the most popular iterative methods are tested and evaluated. The best performing preconditioned conjugate gradient (PCG) is very well suited for vector and parallel processing as is demonstrated for the WLS state estimation of the IEEE standard test systems. A new sparse matrix format for the gain matrix improves vector performance of the PCG algorithm and makes it competitive to the direct solver. Internal parallelism in RISC processors, used in current multiprocessor systems, can be taken advantage of in an implementation of this algorithm.

2980 Consumption and Utilization

Refer also to citation(s) 6770

6828 (DOE/EIA–0464(91)) **Household vehicles energy consumption 1991.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. 9 Dec 1993. 219p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004426. Source: OSTI; NTIS; GPO Dep.

The purpose of this report is to provide information on the use of energy in residential vehicles in the 50 States and the District of Columbia. Included are data about: the number and type of vehicles in the residential sector, the characteristics of those vehicles, the total annual Vehicle Miles Traveled (VMT), the per household and per vehicle VMT, the vehicle fuel consumption and expenditures, and vehicle fuel efficiencies. The data for this report are based on the household telephone interviews from the 1991 RTECS, conducted during 1991 and early 1992. The 1991 RTECS represents 94.6 million households, of which 84.6 million own or have access to 151.2 million household motor vehicles in the 50 States and the District of Columbia.

6829 (NEDO-P–9255) **Report of feasibility study on international-cooperation in high efficient energy conversion technology.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 250p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE94732340. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

With regard to accelerated introduction of high efficient energy conversion technology to developing countries, the paper investigates the countries' thoughts of the introduction of the technology and the status of the introduction bases. The countries for survey are the Philippines, Indonesia, Malaysia and Thailand. The Philippine government expects to develop cogeneration as well as large power sources and to widen effective use of natural energy. In Indonesia, they largely expect effective use of biomass energy using Stirling engines by international cooperation and the promoted local electrification using standalone distributed fuel cells. In Malaysia, they have great expectations of the introduction of air conditioning facilities using Stirling engines and the use of standalone distributed fuel cells for promotion of local electrification. Thailand hopes for the use of Stirling engines to air conditioning systems, and the development of solar Stirling generators with solar energy as a heat source and electric vehicles. 14 refs., 15 figs., 21 tabs.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 6427, 6466, 6507, 6508, 6509, 6510, 6540, 6829, 6919

6830 (DOE/FTR–93018122) **Travel for investigating prospects for renewable energy activities in Mexico: Trip report, May 18–28, 1991.** Smith, G.J. II (Oak Ridge Associated Universities, Inc., TN (United States)); Rovero, C.; Belcher, M.G.L.; Pate, R.; Nelson, V. Oak Ridge Associated Universities, Inc., TN (United States). 14 Aug 1991. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE93018122. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The purpose of this trip was to meet with Mexican government, parastatal, and private sector officials to define and discuss tasks under the cooperative technical assistance program between the government of Mexico (GOM) and the US Department of Energy (DOE) and the US Agency for International Development (AID). The GOM has recently instituted a poverty alleviation and rural development program, which emphasizes the delivery of social services (water, sanitation, health, education, and electricity) to historically unserved or underserved populations. Under this program renewable energy systems have been used to electrify a number of rural villages, and preparations are under way to greatly expand the scope and pace of rural electrification based on small-scale renewable energy systems. There are many areas where US technical assistance and training efforts could assist this renewable energy program. In the utility sector, Mexico is currently not employing renewable systems for central station generation, with the major exception of large hydro facilities. There is interest, however, in using wind, solar thermal and biomass for on-grid power generation. A number of areas have been identified where US technical assistance can help lay a foundation for large-scale renewable energy activities. The ORAU/ORNL project team travelled to Mexico at the end of March and in the beginning of April to launch a cooperative program in renewable energy technical assistance and training. This report covers the second mission, which included – in addition to ORAU staff – a photovoltaic specialist from Sandia National Laboratory and a wind specialist funded by the Export Council for Renewable Energy (ECRE).

6831 (LUTFD2-TFEM–93-1005) **Energy systems in transition: An analysis of technology, economy, and policy aspects.** Nilsson, Lars J. Lund Inst. of Tech. (Sweden). Dept. of Environmental and Energy Systems Studies. Sep 1993. 32p. Order Number DE94730420. Source: OSTI; NTIS.

The main alternatives to fossil fuels for providing energy services are higher efficiency in the end-use of energy, renewable sources of fuels and electricity, and nuclear power. Aspects of each of these alternatives are analyzed in this thesis. The diversion of nuclear materials and technology is the major risk associated with nuclear power, in addition to accidents and waste handling. The first article reviews the prospects for extending the international control and internationalizing significant parts of the nuclear enterprise, as originally proposed in 1946. In the second article, trends in energy intensities for 31 countries are evaluated, over the period from 1950 to 1988, using a purchasing power parity-based GDP measure and United Nations energy statistics. Economic growth outpaces the growth in energy and electricity demand in many countries, resulting in decreasing national energy and electricity intensities. In article three, electricity use and efficiency in pumping and air-handling systems are assessed. A number of case studies show that electricity use can be reduced by 50 to 75 per cent through system-wide cost-effective modifications. In article four, the lack of performance specifications when procuring air-handling systems, and the incentive structure in the building sector are identified as the main barriers to the implementation of cost-effective efficiency improvements in air-handling systems. Wind power producers cannot trade their output based on marginal operating cost, or place bids on a spot market, since operating costs are essentially zero and the output is intermittent. Wind power is therefore likely to be priced below its value in future electricity markets, unless proper pricing mechanisms are developed. 69 refs

6832 (NEI-DK–1373-Vol.1, pp. 144-149) **Technology assessment and the severn barrage.** Plowden, B. (Council for the Protection of Rural England (United Kingdom)). Teknologinaevnet, Copenhagen (Denmark). 1993. (CONF-9211286–Vol.1: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). In *Technology and democracy. Vol. 1: The use and impact of technology assessment in Europe. Proceedings.* 351p. Order Number DE94730319. Source: OSTI; NTIS.

The Severn barrage has been proposed to harness the potential power of the tidal range of the Severn Estuary to generate electricity. The potential size, cost and environmental impact of the barrage necessitates scrupulous and comprehensive assessment

of its benefits and costs. The assessment carried out to date, while extensive, is an inadequate basis for a decision about whether the project should proceed. Development and deployment of particular technologies is the outcome of political choices. Assessment of different technological options for achieving policy goals must therefore take place at a strategic level. (au)

6833 (NEI-DK–1373-Vol.1, pp. 150-155) **The Severn Barrage project.** Wardle, D.G. (Balfour Beatty Ltd. (United Kingdom)). Teknologinaevnet, Copenhagen (Denmark). 1993. (CONF-9211286–Vol.1: 3. European congress on technology assessment, Copenhagen (Denmark), 4-7 Nov 1992). In *Technology and democracy. Vol. 1: The use and impact of technology assessment in Europe. Proceedings.* 351p. Order Number DE94730319. Source: OSTI; NTIS.

This paper gives a brief outline of previous Severn Estuary Barrage proposals leading to the present barrage location and layout. The methodology adopted for the studies is described showing the strong linkages between all aspects and the involvement of many organisations. The study results are given together with an indication of the subsequent consultations and on-going further studies. (au)

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

6834 (DOE/ET/10815–208) **Superheater/intermediate temperature airheater tube corrosion tests in the MHD Coal Fired Flow Facility (Eastern Coal Phase).** White, M.K. Tennessee Univ., Tullahoma, TN (United States). Space Inst. Nov 1993. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-79ET10815. (UTSI–93-03). Order Number DE94003126. Source: OSTI; NTIS; GPO Dep.

Corrosion data have been obtained for tub is exposed for 1500–2000 hours in a proof-of-concept magnetohydrodynamics (MHD) power generation test facility to conditions representative of superheater and intermediate temperature air heater (ITAH) components. The tubes, coated with K_2SO_4-rich deposits, were corroded more than in most pulverized coal fired superheater service, but much less than the highly aggressive liquid phase attack encountered in conventional plants with certain coals and temperatures. Results indicated that, with parabolic corrosion kinetics, type 310 and 253MA stainless steels should be usable to 1400F at hot end of ITAH. At final superheater temperatures, 2.25 and 5 Cr steels were indicated to have parabolic corrosion rates generally below a 0.5 mm/yr criterion, based on corrosion scale thickness. However, unknown amounts of scale loss from spallation made this determination uncertain. Stainless steels 304H, 316H, and 321H had parabolic rates variably above the criterion, but may be servicable under less cyclic conditions. Corrosion rates derived from scale thickness and intergranular corrosion depth measurements are reported, along with scale morphologies and compositions. Implications of results on commercial MHD utilization of the alloys are discussed, as well as the indicated need for more corrosion resistant alloys or coatings under the most severe exposure conditions.

6835 (DOE/ID/12735–T28) **Projects at the Component Development and Integration Facility: Quarterly technical progress report, April 1–June 30, 1993.** MSE, Inc., Butte, MT (United States). [1993]. 31p. Sponsored by USDOE, Washington, DC {United States). DOE Contract AC22-88ID12735. Order Number DE94003657. Source: OSTI; NTIS; GPO Dep.

This quarterly technical progress report presents progress on the projects at the Component Development and Integration Facility (CDIF) during the third quarter of FY93. The CDIF is a major US Department of Energy test facility in Butte, Montana, operated by MSE, Inc. Projects in progress include: MHD Proof-of-Concept Project; Mine Waste Technology Program; Plasma Projects; Resource Recovery Project; Sodium Sulfide/Ferrous Sulfate Project; Soil Washing Project; and Spray Casting Project.

3004 Thermionic Converters

Refer also to citation(s) 6631, 6632, 6634

3005 Fuel Cells

Refer also to citation(s) 6577, 6954, 7022, 7023

6836 (DOE/MC/29227–3510) **An economic feasibility analysis of distributed electric power generation based upon the natural gas-fired fuel cell: a model of a central utility plant.** Southern California Gas Co., Los Angeles, CA (United States). 30 Jun 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-92MC29227. Order Number DE94000040. Source: OSTI; NTIS; GPO Dep.

This central utilities plant model details the major elements of a central utilities plant for several classes of users. The model enables the analyst to select optional, cost effective, plant features that are appropriate to a fuel cell application. These features permit the future plant owner to exploit all of the energy produced by the fuel cell, thereby reducing the total cost of ownership. The model further affords the analyst an opportunity to identify avoided costs of the fuel cell-based power plant. This definition establishes the performance and capacity information, appropriate to the class of user, to support the capital cost model and the feasibility analysis. It is detailed only to the depth required to identify the major elements of a fuel cell-based system. The model permits the choice of system features that would be suitable for a large condominium complex or a residential institution such as a hotel, boarding school or prison. The user may also select large office buildings that are characterized by 12 to 16 hours per day of operation or industrial users with a steady demand for thermal and electrical energy around the clock.

6837 (DOE/MC/29227–3511) **An economic feasibility analysis of distributed electric power generation based upon the Natural Gas-Fired Fuel Cell: a model of the operations cost.** Southern California Gas Co., Los Angeles, CA (United States). 30 Jun 1993. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-92MC29227. Order Number DE94000041. Source: OSTI; NTIS; GPO Dep.

This model description establishes the revenues, expenses incentives and avoided costs of Operation of a Natural Gas-Fired Fuel Cell-Based. Fuel is the major element of the cost of operation of a natural gas-fired fuel cell. Forecasts of the change in the price of this commodity a re an important consideration in the ownership of an energy conversion system. Differences between forecasts, the interests of the forecaster or geographical areas can all have significant effects on imputed fuel costs. There is less effect on judgments made on the feasibility of an energy conversion system since changes in fuel price can affect the cost of operation of the alternatives to the fuel cell in a similar fashion. The forecasts used in this model are only intended to provide the potential owner or operator with the means to examine alternate future scenarios. The operations model computes operating costs of a system suitable for a large condominium complex or a residential institution such as a hotel, boarding school or prison. The user may also select large office buildings that are characterized by 12 to 16 hours per day of operation or industrial users with a steady demand for thermal and electrical energy around the clock.

6838 (ECN-RX–93-105) **Characterization of solid oxide fuel cell electrodes by impedance spectroscopy and I-V characteristics.** Van Berkel, F.P.F.; Van Heuveln, F.H.; Huijsmans, J.P.P. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Oct 1993. 14p. Order Number DE94729809. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

Contribution to the 9th International Conference on Solid State Ionics, The Hague, Netherlands, September 12-17, 1993.

Impedance spectroscopy has been used to optimize the three-phase-boundaries of porous electrodes in solid oxide fuel cells. The three-phase-boundaries (TPB's) are the sites where the electrode reaction occurs and their nature is determined by the

microstructure of the electrode. The TPB-length (TPBL) of the cathode can be optimized by using small powder particles and a high loading of the particles on the electrolyte surface. The TPBL of the Ni/8YSZ-anode can be optimized by using small Ni-particles and a high 8YSZ/Ni-particle size ratio. 5 figs., 4 tabs., 8 refs.

6839 (LUNKDL-NKOO–1022) **Fuel cell electro catalysis; A spectroscopic study.** Wideloev, A. Lund Univ. (Sweden). Dept. of Inorganic Chemistry I. Oct 1993. 61p. Order Number DE94730404. Source: OSTI; NTIS.

Two catalyst systems, for the ultimate use in fuel cell electrodes, have been studied with spectroscopic and general electrochemical methods. Macrocyclic metal N_4-chelates, one of these catalyst systems, are after certain preliminary preparation steps candidates for the use as electro catalysts in the cathodic reduction of dioxygen. The preliminary preparation consists in a heat-treatment that for yet unknown reasons increases the activity and stability of these catalysts. Metal N_4-macrocycles, particularly cobalt and iron tetraphenylporphyrins, in various preparation mixtures with carbon, have been heat-treated at temperatures between 300-1000 deg C. Measurements of catalytic activity have been correlated with ESCA and Moessbauer measurements. Carbon supported porphyrins undergo partial decomposition upon pyrolysis and in this process stable bonds with the carbon matrix are formed which stabilize the metal N_4-unit and facilitates electron transfer between MN_4-unit and support. The MN_4-unit remains intact in this process and is thus concluded to be the active site. Pure crystalline porphyrins polymerize upon pyrolysis with a concomitant increase in conductivity which is the reason for the increase in activity for these catalysts. The second catalytic reaction under study is the electrocatalytic reduction of methanol on platinum - a reaction that takes place at the anode in a methanol fuel cell. This reaction does only reach completion at potentials that are much higher than the reversible potential because of the formation of a tenaciously held reaction intermediate. ESCA and SIMS measurements have been employed to reveal the identity of this intermediate that is not yet fully known. For Pt-sheets used in methanol oxidation some CO-species can be detected, but there is an abundance of other hydrocarbons as well. 105 refs, 12 figs

6840 (PNL-SA–22654) **Oxygen reduction at a YSZ interface with cathode materials La_{1-x}(Ca or Sr)$_x MnO_3$ or $Y_{1-x}CaMnO_3$.** Youngblood, G.E.; Windisch, C.F. Jr.; Bates, J.L. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9309106–2: 14. international symposium on materials science, Roskilde (Denmark), 6-10 Sep 1993). Order Number DE94002954. Source: OSTI; NTIS; GPO Dep.

Impedance spectroscopy combined with an unbonded interface cell (UIC) design, was used to assess oxygen reduction at an yttria-stabilized zirconia electrolyte interface with several substituted yttrium and lanthanum manganite cathode compositions. By analyzing impedance spectra taken using the UIC, effective length of reaction zone at the solid-gas triple phase boundary can be estimated and used to normalize the oxygen reduction reaction rate for each cell, thus effectively removing effect of interface morphology. Intrinsic reaction rates (specific oxygen activities) were determined from spectra as function of temperature and oxygen partial pressure for cathodes La_{1-x}(Ca or Sr)$_x MnO_3$ and $Y_{1-x}Ca_xMnO_3$ (LCM, LSM and YCM, respectively) and for Pt. Specific activities in the temperature and $P(O_2)$ ranges of an operating solid oxide fuel cell (SOFC) cathode, 1173–1273K and 10^5-10^3 Pa, were highest for LCM intermediate for YCM and lowest for LSM. For LCM and YCM, compositions with x=0.5 gave highest specific activities. Specific activities for all of the tested manganite compositions exceeded the platinum specific activities by at least an order of magnitude. Shapes of impedance spectra for all the manganite systems were similar. Examination of spectra shapes revealed that the overall cathodic polarization process was rather complex and made up of at least two or more fundamental steps.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

6841 (ANL/DIS/CP–81461) **The effects of regional climate change on space conditioning needs and the energy industry in the Great Lakes region.** Fernau, M.E. (Argonne National Lab., IL (United States)); Maloney, E.D.; Bates, G.T. Argonne National Lab., IL (United States). [1993]. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310135–3: 32. Hanford symposium on health and the environment, Richland, WA (United States), 18-21 Oct 1993). Order Number DE94004610. Source: OSTI; NTIS; INIS; GPO Dep.

To date, studies of the effects of potential climate change on energy use and demand have been done on a macro scale or with coarse model data but, in reality, regional climate change effects will determine the actual behavior of energy users. The output from a 3-year simulation of the coupled NCAR CCM/MM4 regional climate modeling system is used to examine changes in average temperature and temperature variability on a regional scale, the impacts of such change on the need for space conditioning in the Great Lakes region, and the subsequent changes in energy demand. The NCAR modeling system uses general circulation model results to drive a more highly resolved mesoscale model to produce a detailed regional climate. A 3-year run of both base case and doubled CO_2 climate for the United States has been produced. From these results, changes in heating and cooling degree days, and changes in consecutive days above or below various temperature thresholds were calculated. Heating and cooling energy use intensities that are representative of the residential building stock found in the region were used to convert climate data to energy demand. The implications for the energy industry are discussed. The model results indicate that the changed climate under doubled carbon dioxide conditions would have large impacts on energy use, although it is difficult to determine the balance between decreased heating needs and increased cooling needs. It was found that biases present in the temperature output of the modeling system are greater for the Great Lakes region than for the rest of the U.S. and limit the usefulness of the present data set for determining the effects of climate change on energy use in that area.

3201 Buildings

Refer also to citation(s) 6486, 6898, 6909, 7111, 7399

6842 (CONF-9308189–1) **Environmental benefits of different types of heat pumps, available and expected.** Hughes, P.J. Oak Ridge National Lab., TN (United States). [1993]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 2. international conference on heat pumps in cold climates; Moncton (Canada); 16-17 Aug 1993. Order Number DE94002440. Source: OSTI; NTIS; GPO Dep.

A brief overview of integrated resource planning (IRP) is provided, with emphasis on how stakeholders interact within the process and where the opportunities may lie for heat pump advocates in cold climates. Five heat pump options that represent various approaches for improving heat pump cold weather performance are included here in a comparative analysis: 2-speed electric air source heat pumps, variable-speed electric air source heat pumps, electric ground-source heat pumps, natural gas engine-driven heat pumps, and natural gas absorption heat pumps. The comparative analysis addresses seasonal performance, seasonal peak demand, air pollutant emissions, customer energy costs, and recognition of environmental externalities in IRP, all in the context of a residential application in the Great Lakes region of the US. Several actions that may be in the interest of heat pump stakeholders in cold climates were identified, including: development of improved software for utility planners, advocacy of a practical form of the Societal Test for use in IRP that credits heat pumps for the residential air pollutant emissions that they avoid, and development of practical methods to credit heat pumps with other environmental benefits for which they may be responsible.

6843 (CONF-9311131–1) **Interlaboratory comparison of the horizontal pipe insulation test apparatus up to 350°C.** Whitaker, T.E. (Pabco, Fruita, CO (United States)); Graves, R.S.;

McElroy, D.L.; Smith, D.R. Oak Ridge National Lab., TN (United States). [1993]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 22. international thermal conductivity conference; Tempe, AZ (United States); 7-10 Nov 1993. Order Number DE94003498. Source: OSTI; NTIS; GPO Dep.

The purpose of this interlaboratory comparison was to provide information for the precision and bias section in the ASTM Standard Test Method C 335, "Steady-State Heat Transfer Properties of Horizontal Pipe Insulation." (The text describes the ASTM C 335 test method, the specimens tested and the test protocol). The apparent thermal conductivity of two rigid calcium silicate pipe insulation specimens was measured by eight laboratories. Each laboratory measured both specimens at four different temperatures. The test mean temperatures ranged from 35 to 390°C. The two standard deviation value for the data ranged from 4.5 to 7.7% and the average value was 6.3%. The statement recommended for the precision and bias statement for Section 13.1.4 of ASTM C 335 is: "Tests performed at seven different laboratories using guarded-end horizontal pipe test apparatus and at one laboratory using an unguarded cylindrical screen test apparatus on two specimens of calcium silicate insulation in the range of mean temperatures from 35 to 390°C did not vary by more than 6.3% (two standard deviations) of the average."

6844 (DOE/EE–0008) **Advanced lighting guidelines: 1993: Final report.** Eley, C. (Eley Associates, San Francisco, CA (United States)); Tolen, T.M.; Benya, J.R.; Rubinstein, F.; Verderber, R. Eley Associates, San Francisco, CA (United States); Luminae Souter Lighting Design, San Francisco, CA (United States); Lawrence Berkeley Lab., CA (United States). 1993. 186p. Sponsored by USDOE, Washington, DC (United States);California Energy Resources Conservation and Development Commission, Sacramento, CA (United States);Electric Power Research Inst., Palo Alto, CA (United States). Order Number DE94005264. Source: OSTI; NTIS; GPO Dep.

The 1993 Advanced Lighting Guidelines document consists of twelve guidelines that provide an overview of specific lighting technologies and design application techniques utilizing energy-efficient lighting practice. Lighting Design Practice assesses energy-efficient lighting strategies, discusses lighting issues, and explains how to obtain quality lighting design and consulting services. Luminaires and Lighting Systems surveys luminaire equipment designed to take advantage of advanced technology lamp products and includes performance tables that allow for accurate estimation of luminaire light output and power input. The additional ten guidelines – Computer-Aided Lighting Design, Energy-Efficient Fluorescent Ballasts, Full-Size Fluorescent Lamps, Compact Fluorescent Lamps, Tungsten-Halogen Lamps, Metal Halide and HPS Lamps, Daylighting and Lumen Maintenance, Occupant Sensors, Time Scheduling Systems, and Retrofit Control Technologies – each provide a product technology overview, discuss current products on the lighting equipment market, and provide application techniques. This document is intended for use by electric utility personnel involved in lighting programs, lighting designers, electrical engineers, architects, lighting manufacturers' representatives, and other lighting professionals.

6845 (DOE/FTR–94000755) **Travel to France to participate in the Empirical Validation Study: Foreign trip report, September 20–23, 1993.** Judkoff, R. National Renewable Energy Lab., Golden, CO (United States). 24 Sep 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000755. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Task 12, Solar Building Analysis and Design Tools, is necessary because current simulation programs do not have the capabilities to analyze many of the innovative energy design strategies. At the meeting in France, several activities were addressed: (1) Document Overall Tool Evaluation Methodology Empirical Data Sets and Analytical Solution, (2) Sensitivity Analysis, (3) Benchmark Cases for the Building Fabric (BESTEST), (4) Commercial Benchmark Cases, (5) Model Improvements.

6846 (DTH-LV-MEDD–241) **Non-ventilated solar walls in older apartment buildings - full scale experiment: An evaluation of energy savings and thermal comfort.** Fritzel, P.; Joergensen, O.B. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Værmeisolering. Mar 1993. 39p. (In Danish, English). Contract ENS-1213/90-0001; Contract ENS-1213/91-0001. Order Number DE94730341. Source: OSTI; NTIS.

EFP-90; EFP-91.

With regard to solar walls, two profile systems were tested for tightness against rain penetration and for mechanical strength, and the stability of form of a transparent insulation material was tested at different temperatures. The test facility consisted of a system of sprinklers and suckers simulating rain and wind force. It was proved that Isoflex preserves its stability of form when heated to 98 deg. C during 35 minutes as well as up to 120 deg. C during 12 minutes. Its capacity for resisting UV radiation was considered sufficient. Results showed that total energy saved by constructing a solar wall on a SSE oriented gable was 6700 kWh during a moderate firing period, corresponding to 83 kWh/m^2. The saving for a flat with a solid outer wall behind the solar wall will be 2900 kWh or 125 kWh/m^2, while the saving in a flat with an insulated cavity wall will be 1900 kWh or 66 kWh/m^2. An external, extra insulation of 100 mm mineral wool will save 4000 kWh, corresponding to a saving of 60 kWh/m^2, 96 kWh/m^2 on the solid wall and 38 kWh/m^2 on the cavity wall. The thermal indoor climate was satisfactory in the case of the solar wall. The surface temperature on the inside of this wall increased 1 to 3 deg. C in the course of the year. During a heat wave the temperature in the flat rose to 32 deg. C, also due to the solar heat through the windows (18% of outer wall surface). The conclusion is that the solar wall is a good alternative to traditional insulation of outer walls, especially in the case of solid outer walls. (AB)

6847 (LBL–33943) **WINDOW 4.0: Documentation of calculation procedures.** Finlayson, E.U. (Lawrence Berkeley Lab., CA (United States)); Arasteh, D.K.; Huizenga, C.; Rubin, M.D.; Reilly, M.S. Lawrence Berkeley Lab., CA (United States). Jul 1993. 45p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (TA–309). Order Number DE94004935. Source: OSTI; NTIS; GPO Dep.

WINDOW 4.0 is a publicly available IBM PC compatible computer program developed by the Building Technologies Group at the Lawrence Berkeley Laboratory for calculating the thermal and optical properties necessary for heat transfer analyses of fenestration products. This report explains the calculation methods used in WINDOW 4.0 and is meant as a tool for those interested in understanding the procedures contained in WINDOW 4.0. All the calculations are discussed in the International System of units (SI). WINDOW 4.0 is the latest in a series of programs released by the Lawrence Berkeley Laboratory. The WINDOW program has its roots in a paper detailing a method for calculating heat transfer through windows [Rubin, 1982]. WINDOW 4.0 replaces the widely used 3.1 version. Although WINDOW 4.0 is a major revision, many of the algorithms used in WINDOW 4.0 build upon those previously documented [Arasteh, 1989b], [Furler, 1991]. This report documents the calculations that are unchanged from WINDOW 3.1, as well as those calculations that are new to WINDOW 4.0. This report uses the organization of the WINDOW 4.0 program. Results displayed on a WINDOW 4.0 screen are discussed in a section describing that screen. In the conclusion the aspects of the calculation method currently slated for revision are discussed. A glossary of variables used throughout the report is found in Section 11.

6848 (NEI-DK–1353, [pp. 32]) **Energy conservation in Latvia.** Smith-Hansen, O. (Rockwool A/S, Hedehusene (Denmark)). PA Consulting Group A/S, Lyngby (Denmark). 1993. Contract IMOe-425. In *Issues and options in the energy sector in Latvia. Vol. 1: Background reports. Energy conservation in Lativa. Energy utilities and pricing.* 51p. Order Number DE94730158. Source: OSTI; NTIS.

This preliminary report is part of the project 'Issues and Options Analysis for Rational Energy Management in Latvia', managed by PA Consulting Group. The report is based on a 2-week visit to Riga, Latvia, in the period 1992.09.05-09.19 as well as on a study of available reports. The contents deal with: energy conservation in

general, energy savings in industry and energy savings in buildings. In East Europe economic states subsidies were used to keep energy prices artificially low. The present transition from planning economy to market economy also comprises a gradual price increase for energy to world market levels, hopefully resulting in incentives to invest and adapt to the changed energy situation. Latvia and other East-European countries face the problem of huge investments distribution over a short period. Due to lack of capital, know-how and modern equipment an intensified East-West cooperation is necessary. This report is meant to be a tool for the purposes of priority defining in energy conservation programs in industry and buildings. (EG)

6849 (NEI-DK–1356) **Ecological urban renewal in Copenhagen: A European model.** Hjort Knudsen, H. Miljoekontrollen, Copenhagen (Denmark). 1993. 91p. Contract B4-3045(91)18NH. Order Number DE94730216. Source: OSTI; NTIS.

The Agency of Environmental Protection, City of Copenhagen has carried out the project "Planning Model for Ecological Renewal of Old City Areas" with support from the EC, DGXI. The overall aim of the study was to describe a planning model for ecological renewal of old European city areas using as a basis the ecological renewal of the Vesterbro district in Copenhagen. General conditions for urban renewal in Copenhagen are described. The overall infrastructural planning and strategies are briefly described together with a presentation of the specific renewal area. Finally the legislative, organisational and economic conditions for urban renewal are presented. The ecological planning process as it has actually developed and a study of the ecological potential for minimizing the consumption of resources and the environmental impact within the areas of energy, waste, water, greening of the district etc. are described. Barriers to and tools for the implementation of ecological solutions are analysed. The analysis describes which obstacles can arise to the implementation in the different areas, and gives an account of a number of tools available in the planning phase. A brief description of the experience with ecological renewal in Amsterdam, Berlin, Genoa and Madrid is given. Some general conditions for urban renewal and ecological implementation are focused upon. with reference to the analysis of the Copenhagen Model and the results achieved in the four cities some general ecological guidelines for European cities are given. (AB)

6850 (NEI-DK–1360) **Heat pumps and energy-absorber as heat absorbers.** Aagaard, H.C. Dansk Teknologisk Inst., Taastrup (Denmark). Proevestationen for Varmepumpeanlaeg. Dec 1992. 40p. (In Danish). Contract ENS-1223/89-10. Order Number DE94730342. Source: OSTI; NTIS.

EFP-89.

With regard to heat pumps with uncovered solar collectors as the only heat absorbers, very high temperatures (> 50 deg. centigrade) can arise in the latter during the summer. Other problems are constructional damage when the solar collector is integrated in a building, heat pump dropout in the event of snow drifting, icing or too high temperatures, lower capacity, reduced operational economy, and leakages (especially where alcohol is used as an antifreeze medium) followed by necessary operational closedowns. It should be noted that building regulations demand that there must be no risk of fire or explosions related to heat pump installations. In order to document these problems, questionnaires were sent out and system measurements were taken. The results are presented in detail. System measurements showed that the heat pump's compressor can be safeguarded from exposure to evaporation temperatures of over 10 deg. centigrade, whilst the flow temperature from the condenser is approximately 54 deg. centigrade, by the use of a thermostatic expansion valve with limited opening possibilities located in the refrigerating circuit. It is recommended that solar collectors used in relation to heat pumps should only be utilized in connection with ground coils, and only if there is sufficient "ground coil area" available. It is suggested that a better and cheaper solution would be to use a standard aggregate with laminar heat surfaces instead of solar collectors/heat absorbers. Here ground coils could be used to join up the system. (AB)

6851 (NEI-DK–1390) **Effective use of fluorescent lamps and tubes: Development of spotlight comprising compact fluorescent tubes. Dimensioning of reflectors. Development of electronic ballast. Evaluation of economical and environmental aspects.** Poulsen (L.) og Colombia A/S, Copenhagen (Denmark); JL Eletronics ApS, Them (Denmark); Lys og Optik, Lyngby (Denmark); Danmarks Tekniske Hoejskole, Lyngby (Denmark). Fysik-Kemisk Inst. Aug 1993. 147p. (In Danish). Contract ENS-1223/91-0004. Order Number DE94730337. Source: OSTI; NTIS.

EFP-91.

The development of fittings for compact fluorescent lamps is described with regard to a spotlight for effective illumination in a shop. A reflector, the use of which results in the spotlight giving out a radiance which is just as strong as when similar fittings are used with incandescent lamps, was designed. The reflector is larger than that used with incandescent lamps and this has an influence on the design of the fitting. In addition to this a high frequency electronic ballast which helps to prevent flimmer and a fitting which does not overload the network or give noise problems were designed. The ballast is integrated in the light fitting which reduces the overall dimension and makes it easier to reduce noise. The extra cost of the fitting can be covered by the savings achieved during operation in the course of a few years. Especially in relation to the use of mercury it was shown that the use of fittings of this design has definite environmental advantages. (AB) (11 refs.)

6852 (NEI-SE–135) **Air-handling energy efficiency and design practices.** Nilsson, Lars J. Lund Inst. of Tech. (Sweden). Dept. of Environmental and Energy Systems Studies. 1993. 25p. Order Number DE94002062. Source: OSTI; NTIS.

Paper included in the dissertation of Lars J. Nilsson.

With good design practices and life-cycle cost optimization, specific fan power for individual fans will be between 0.5 and 1kW/m^3/s. Data from nearly 1000 audited fans in Sweden show that the average measured SFPI weighted by drawn motor power is 1.5 kW/m^3/s and the situation appears to be similar in other countries. Contract forms used by Swedish builders, and consultants' design practices are analyzed here to search for an explanation to the low performance of installed systems. Identified as two major barriers to efficient system design are the lack of performance specifications when procuring systems and the incentive structure in the building sector. As a consequence, duct design methods, rules of thumb, and vendor recommendations are not leading to system optimization. The broad minima in life cycle costs over a range of air-handling unit sizes show that potential economic welfare losses from efficiency standards are likely to be smaller than the losses that result from today's design practices. 73 refs, 4 figs, 3 tabs

6853 (NYSERDA–93-14) **Development of a demand defrost controller: Final report.** Borton, D.N. (Power Kinetics, Troy, NY (United States)); Walker, D.H. Power Kinetics, Troy, NY (United States); Foster-Miller, Inc., Waltham, MA (United States). Oct 1993. 84p. Sponsored by New York State Energy Research and Development Authority, Albany, NY (United States). Source: OSTI; New York State Energy Research and Development Authority, Two Rockerfeller Plaza, Albany, New York 12223.

The purpose of this project was to develop and commercialize a demand defrost controller that initiates defrosts of refrigeration systems only when required. The standard method of control is a time clock that usually defrosts too often, which wastes energy. The controller developed by this project uses an algorithm based on the temperature difference between the discharge and return of the display case air curtain along with several time settings to defrost only when needed. This controller was field tested in a supermarket where it controlled defrost of the low-temperature display cases. According to test results the controller could reduce annual energy consumption by 20,000 and 62,000 kWh for hot gas and electric defrost, respectively. The controller saves electric demand as well as energy, is adaptable to ambient air conditions, and provides valuable savings throughout the year. The savings are greatest for low-temperature systems that use the most energy. A less tangible benefit of the demand controller is the improvement in food quality that results from fewer defrosts.

6854 (ORNL/FTR–4769) **Travel to France, Switzerland and the Netherlands to represent the DOE/ORNL Building Envelopes Research Program at the Workshop on Building Envelopes as Energy Systems: Foreign trip report, September 7–16, 1993.** Christian, J.E. Oak Ridge National Lab., TN (United

States). 27 Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94000982. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The traveler was requested to attend the IEA Workshop in Zoetermeer by Richard Karney, DOE and given two assignments. The first, to gain important insight from the international community which would help us sharpen our long range building envelopes research program activities. The desired outcome would lead to greater US potential economic gain in the global market. The second assignment was to look for opportunities to contribute ORNL envelope systems research findings toward the international effort of improving the global energy efficiency of building envelopes. The workshop attendees agreed that a proposal for an IEA working annex should be proposed to the Exco. The traveler was nominated by the other US participants to take the lead in preparing a US version of an abstract for a Future Building Envelopes IEA Annex.

6855 (PNL–7974) **Construction cost impact analysis of the U.S. Department of Energy mandatory performance standards for new federal commercial and multi-family, high-rise residential buildings.** Di Massa, F.V.; Hadley, D.L.; Halverson, M.A. Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004569. Source: OSTI; NTIS; INIS; GPO Dep.

In accordance with federal legislation, the U.S. Department of Energy (DOE) has conducted a project to demonstrate use of its Energy Conservation Voluntary Performance Standards for Commercial and Multi-Family High-Rise Residential Buildings; Mandatory for New Federal Buildings; Interim Rule (referred to in this report as DOE-1993). A key requisite of the legislation requires DOE to develop commercial building energy standards that are cost effective. During the demonstration project, DOE specifically addressed this issue by assessing the impacts of the standards on (1) construction costs, (2) builders (and especially small builders) of multi-family, high-rise buildings, and (3) the ability of low-to moderate-income persons to purchase or rent units in such buildings. This document reports on this project.

6856 (PNL-SA–22644) **An overview of the federal energy management toolkit.** Currie, J.W. (Pacific Northwest Lab., Richland, WA (United States)); Parker, G.; DeVine, K.D. Pacific Northwest Lab., Richland, WA (United States). Aug 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930895–3: International energy and environmental congress, Minneapolis, MN (United States), 4-5 Aug 1993). Order Number DE94004266. Source: OSTI; NTIS; GPO Dep.

The federal government is the single largest energy user in the US. The annual cost to the American taxpayer for supplying energy to buildings, facilities, and operations within the federal sector is $5 billion. Several estimates have been produced projecting that up to 40% of this annual cost could be saved through energy efficient actions. Pacific Northwest Laboratory (PNL) and other DOE laboratories provide technical assistance to the Department of Energy (DOE) Federal Energy Management Program (FEMP) and other federal agencies to identify, evaluate, and prioritize the most cost-effective actions to improve energy efficiency and reduce energy costs at federal installations. A key feature of this program is the development and application of a comprehensive set of software tools, analyses, procedures, operations and maintenance approaches, and the transfer of knowledge through technical assistance and demonstration activities. PNL and other federal laboratories are cooperating with FEMP and other federal agencies in applying these tools at over 50 federal sites containing over 60 central utility systems and more than 50,000 buildings and facilities. The overall approach employed by FEMP is fuel- and technology-neutral. This means that by applying the FEMP approach, the least-cost way to provide heat, cooling, and other energy services is identified without regard to whether or not the energy source is electricity, natural gas, or other fuel forms.

6857 (SJF-BERETNING–55) **Control of climate and production in pig confinement buildings.** Moeller, F. Statens Jordbrugstekniske Forsoeg, Horsens (Denmark). 1993. 29p. (In Danish). Order Number DE94730332. Source: OSTI; NTIS.

A project was carried out in order to study the technical potential for continuous climate and production control recording in pig units. The data are transferred to a centrally located computer, and displayed as daily reports or graphs. A climate controller for chicken units, after some modifications, can be used for climate control in a pig unit and to record data on temperature, humidity, energy consumption, water and feed consumption and animal weight. The project proved that the climate monitoring system functions satisfactorily, it allows overall monitoring of current temperature and air humidity, and any deviations can be controlled. It can also be used for close study of the climate over a specific period in each individual unit, thus permitting the user to control the performance of the ventilation and heating systems. The computer can change the adjustment of the connected climate control unit. Via a modem connected to the public telephone network the ventilation company can be logged in to the monitoring system. The data collected can be used as a basis for keeping the user to date on the daily weight gain and feed consumption of the animals. (AB)

6858 (SP–93-18) **Indoor air quality in airtight swedish dwellings: A follow-up study of 44 single-family houses built in 1982-89.** Nilsson, I. Swedish National Testing and Research Inst., Boraas (Sweden). Jun 1993. 62p. (In Swedish). Order Number DE94730433. Source: OSTI; NTIS.

Indoor air quality and durability of air tightness and ventilation function in buildings were studied in 44 single-family houses built by the same contractor (Hjaeltevad AB) between 1982 and 1989. The investigation comprised measurements of ventilation rate, air tightness and volatile organic compounds (VOC) in the indoor air, as well as inspection of the house. The dwellings have exhaust air heat pumps. Ventilation rate and air tightness were checked in all houses when they were new. In this study these measurements were repeated. From the start all houses met the requirements in the Swedish Building Code of a minimum ventilation rate of 0.5 air changes per hour. The houses were initially also very airtight. Now, 3-10 years later, the ventilation rate in practically every house has decreased; on an average 25%. The air tightness is still good, but the results show on an average a slight deterioration. The total concentration of volatile organic compounds (TVOC) in the houses were in the range of 0.08 to 1.43 mg/m^3 (Tenaxadsorbent, GC-FID, toluene-equivalents). In two houses, TVOC-levels above 1 mg/m^3 where caused by a non-functioning exhaust fan and work with artists paint respectively. Excluding these two houses, the arithmatic mean value was 0.30 mg/m^3 and the standard deviation 0.14 mg/m^3. Among individual VOCs identified where α-pinen and other terpenes, aldehydes, hydrocarbons and esters. One compound found in four houses in levels above 0.05 mg/m^3, was TXIB, a semivolatile plasticizer. The source of TXIB in these particular houses was not identified. No simple correlation between TVOC-value and air exchange rate was found. This concludes that other sources than building materials were of significant importance. This was also shown by lack of correlation between age of the building (e.g. surface of the room) and TVOC. More important sources could be furniture, household products and cosmetics. 14 refs, 12 tabs, 57 figs

6859 (SP–93-22) **Loose-fill insulation - Measurement of the thermal resistance.** Jonsson, Bertil. Swedish National Testing and Research Inst., Boraas (Sweden). 1993. 85p. (In Swedish). Order Number DE94730434. Source: OSTI; NTIS.

SP has reviewed the various types of materials available for use as loose-fill insulation, together with their characteristics. It is important that samples for testing in the laboratory are correctly prepared, in a manner that is representative of their in-situ installation in normal applications. The material must be teared apart and blown out as it would be when being laid normally. Loose-fill insulation materials have been laid in a specially constructed instrumented test roof space, and have also been sprayed and prepared for testing in various test frames used for laboratory measurements. Comparisons have been made between the results of in-situ measurements of materials and laboratory measurements. In addition, the feasibility of taking samples from in-situ materials and preparing them for testing by hand have also been investigated. Comparison of various methods of filling the test frames with loose-fill material by hand and filling them by blowing the material directly

into the frames has shown that is feasible to develop a method of preparing samples for testing by hand.Tests have been carried out on five different types of materials: polystyrene beads, two types of glass wool, mineral wool and cellulose fibre. Varying thickness have been used in order to investigate the effects of edge conditions. The materials that have been investigated produced different types of characteristic curves when plotting the thermal resistance against thickness. Convection effects * within materials having an isothermal upper surface, * within materials having a non isothermal upper surface (closed surface) and * involving linked convection between/within the material and the airgap (open surface) have been investigated. 21 refs, 24 figs, 30 tabs

6860 (SP–93-40) **Improvement in electrical efficiency and indoor climate in hospitals - Boraas Hospital.** Larsson, R.; Blomsterberg, Aa. Swedish National Testing and Research Inst., Boraas (Sweden). 1993. 148p. (In Swedish). Order Number DE94730435. Source: OSTI; NTIS.

A study was carried out in Boraas hospital with the aim to improve the indoor climate /(thermal comfort and indoor air quality) and reduce the use of electricity of fans to 2.0 kWh/m^3/s and lighting to 10 W/m^2. The indoor climate was examined using questionnaires and one-time tests. The status of the HVAC equipment was determined by one-time tests. Operating strategies for ventilation and lighting were documented. The total energy use and the energy use of individual components were determined. The main problems concerning the indoor climate were; high indoor temperatures, unbalanced air flows, noise and odours. The problems were often caused by changes in the use of premises. Three main observations were made concerning the HVAC equipment: inadequate operating analysis, complicated systems and new electrical equipment. The electrical savings potential for four buildings has been estimated to be 2040 MWh/year or 28 kWh/(m^2 and year). The measures already carried out and the ones recommended to be carried out include the following areas: ventilation, heat recovery, lighting, transformers, cooling equipment and restaurant kitchen equipment. General measures for the entire hospital include the following areas: lighting in changing- rooms and culverts, transformers and PC screen switch off. The electrical savings potential for these measures is 515 MWh/year. This study has shown that there is a large potential for improvement in the indoor climate and savings in electricity and district heating. Many measures result in important savings without requiring any investment apart from a thorough analysis. Many of these measures originate from a discovered indoor climate problem. 9 refs, 30 tabs

3202 Transportation

Refer also to citation(s) 6819, 7418

6861 (LITH-MAT-R–93-30) **A production-transportation problem with stochastic demand and concave production costs.** Holmberg, K.; Tuy, Hoang. Linkoeping Univ. (Sweden). Dept. of Mathematics. 29 Sep 1993. 21p. Order Number DE94730444. Source: OSTI; NTIS.

Well known extensions of the classical transportation problem are obtained by including fixed costs for the production of goods at the supply points (facility location) or by introducing stochastic demand, modelled by convex nonlinear cost, at the demand points (the stochastic transportation problem, (STP)). However, the simultaneous use of these generalizations is not very well treated in the literature. Furthermore, economies of scale often yield other concave cost functions than fixed charges, so in this paper we generalize the problem even further, by introducing general concave costs at the supply points, as well as convex costs at the demand points. The objective function can be represented as the difference of two convex functions, and is therefore called a d.c. function. We propose a solution method which reduces the problem to a d.c. optimization problem in a smaller space, then solves the latter by a branch and ground procedure in which bounding is based on solving subproblems of the form of STP. We prove convergence of the method and report computational tests that indicate that quite large problems can be solved efficiently. Problems up to the size of 100 supply points and 500 demand points are solved. 19 refs, 5 tabs

6862 (NREL/TP–425-6162) **Demonstration of the fuel economy potential associated with M85-fueled vehicles.** Hodgson, J.W. (Tennessee Univ., Knoxville, TN (United States)); Huff, S.P. National Renewable Energy Lab., Golden, CO (United States); Tennessee Univ., Knoxville, TN (United States). Dec 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE94000245. Source: OSTI; NTIS; GPO Dep.

A gasoline-fueled 1988 Chevrolet Corsica was converted to operate on M85 to demonstrate that the characteristics of methanol fuels can be exploited to emphasize vehicle fuel economy rather than vehicle performance. The results of the tests performed indicated fuel economy improvements of up to 21% at steady highway speeds, and almost 20% on the US Environmental Protection Agency's federal test procedure city and highway cycles.

6863 (NUTEK–91-52291) **Test with combined electric, diesel and wind propulsion of a small fishing boat. Continued testing of electric traction.** Williams, Aa. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). Oct 1992. 30p. (In Swedish). Order Number DE94730442. Source: OSTI; NTIS.

A six meter fishing boat has been equipped with an electric motor for ten years. Problems with batteries and the direct current motor are discussed: Best performance was obtained for a gas recombining battery with gelled electrolyte. Due to the encapsulation of the direct current motor, coal dust from the brushes caused short-circuits in the motor on several occasions. A change to a alternate current motors is suggested for the future. 23 figs

6864 (ORNL/TM–12379) **Prediction and standard error estimation for a finite universe total when a stratum is not sampled.** Wright, T. Oak Ridge National Lab., TN (United States). Jan 1994. 37p. Sponsored by Department of Transportation, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004929. Source: OSTI; NTIS; GPO Dep.

In the context of a universe of trucks operating in the United States in 1990, this paper presents statistical methodology for estimating a finite universe total on a second occasion when a part of the universe is sampled and the remainder of the universe is not sampled. Prediction is used to compensate for the lack of data from the unsampled portion of the universe. The sample is assumed to be a subsample of an earlier sample where stratification is used on both occasions before sample selection. Accounting for births and deaths in the universe between the two points in time, the detailed sampling plan, estimator, standard error, and optimal sample allocation, are presented with a focus on the second occasion. If prior auxiliary information is available, the methodology is also applicable to a first occasion.

6865 **Expansion joint for guideway for magnetic levitation transportation system.** Rossing, T.D. To Dept. of Energy. 1991. U.S. patent application 7-804,555. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94005163. Source: OSTI; NTIS; GPO Dep.

An expansion joint that allows a guideway of a magnetic levitation transportation system to expand and contract while minimizing transients occurring in the magnetic lift and drag forces acting on a magnetic levitation vehicle traveling over the joint includes an upper cut or recess extending downwardly from the upper surface of the guideway and a non-intersecting lower cut or recess that extends upwardly from the lower surface of the guideway. The sidewalls of the cuts can be parallel to each other and the vertical axis of the guideway; the depth of the lower cut can be greater than the depth of the upper cut; and the overall combined lengths of the cuts can be greater than the thickness of the guideway from the upper to lower surface so that the cuts will overlap, but be spaced apart from each other. The distance between the cuts can be determined on the basis of the force transients and the mechanical behavior of the guideway. A second pair of similarly configured upper and lower cuts may be disposed in the guideway; the expansion joint may consist of two upper cuts and one lower cut; or the cuts may have non-parallel, diverging sidewalls so that the cuts have a substantially dove-tail shape.

6866 (TFB–93-5) **Alternative intersection design. A possible way of reducing air pollutant emissions from road and street traffic.** Hoeglund, P.G. (Royal Inst. of Tech., Stockholm (Sweden). Dept. of Traffic and Transport Planning). Swedish Transport Research Board, Stockholm (Sweden). [1993]. 58p. Order Number DE94730428. Source: OSTI; NTIS.

The environmental aspects of intersection design is highly neglected in the planning and construction process. It is necessary to pay attention to the infrastructural design aspects when looking for ways of reducing the traffic related exhaust pollution in the ambient air. It must be possible to find an optimal intersection design for the environment. This report is dealing with the research methodology and survey methods, which could be used in order to find the solution to the problem. Speed-, acceleration- and deceleration profiles are created with the help of field measurements of driving patterns. Data is collected from video pictures taken from a helicopter or from a high mast. Conclusions regarding the differences in pollution levels are then drawn on the basis of the obtained data from before and after micro studies of the traffic flow. The report is also including a before/after case study with a traffic signal intersection changed to a roundabout. The study gave very positive performance results for the roundabout compared with the traffic signal intersection, and as an example it was deduced that if the average driving speed through the intersection in one direction could be increased from 20 km/h to 40 km/h, the HC-emission per vehicle could be decreased from ca 2.5 g/km to ca 1.6 g/km. 17 refs, 22 figs, 10 tabs

3203 Industrial and Agricultural Processes

Refer also to citation(s) 6046, 6161, 6360, 6402, 6442, 6758, 6812, 6816, 6843, 6848, 6853, 6946, 6948, 6949, 6950, 6951, 7013, 7014, 7015, 7016, 7942

6867 (ANL/DIS/CP–81112) **The impact of energy prices on industrial energy efficiency and productivity.** Boyd, G.A. Argonne National Lab., IL (United States). [1993]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94002904. Source: OSTI; NTIS; INIS; GPO Dep.

Energy prices moved into the forefront of concern in the mid and late seventies when two oil price shocks drove up energy prices dramatically. The analysis of the subsequent increase in industrial energy efficiency, i.e., decline in energy use per unit of industrial output, has filled volumes of government and private studies. Despite the volumes of analysis, there remains no consensus on the magnitude of the effect of energy prices on industrial energy efficiency or the effect of the change in energy prices on productivity. This paper examines some sources of the controversy to initiate a dialog between policy makers, analysts, and the energy consumers and producers.

6868 (DOE/ID/12692–4) **Dual cure low-VOC coating process: Phase 3, Semi-annual report, April 1, 1992–September 30, 1992.** Kinzer, K.E. Minnesota Mining and Mfg. Co., St. Paul, MN (United States). Corporate Research Labs. Oct 1993. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-88ID12692. Order Number DE94000365. Source: OSTI; NTIS; GPO Dep.

The objective of Phase 3 of 3M's contract with the US Department of Energy is to complete proof-of-principle testing in full-scale systems of the dual cure photocatalyst technology developed in earlier Phases of the program. The Phase 3 commercial applications to be demonstrated are aerospace topcoats, aerospace primers, and solventless manufacture of tape backings. This report details activities of Phase 3 during this reporting period. In the second six months of Phase 3, work has continued in all three applications. Significant progress has been made in improving the performance of the urethane/acrylate formulation being used for the aerospace topcoat application. Key improvements have been made in obtaining increased reverse impact, initial gloss and gloss retention during accelerated weathering. Technical challenges have continued with the aerospace primer formulation. Efforts in this six months have continued to focus on establishing a good baseline epoxy/acrylate formulation with reliable cure conditions. Work on the third demonstration application, development of solventless backing saturants for electrical tape backings, has essentially been completed. Optimal dual cure resin formulations have been identified and utilized in preparing complete tape constructions. These tapes have been evaluated and characterized in terms of benchmark UL and internal 3M specifications for electrical tape performance.

6869 (DOE/PO–0008) **Efficient electric motor systems for industry. Report on roundtable discussions of market problems and ways to overcome them.** USDOE, Washington, DC (United States). Nov 1993. 82p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94005000. Source: OSTI; NTIS; GPO Dep.

Improving the efficiency of electric motor systems is one of the best energy-saving opportunities for the United States. The Department of Energy (DOE) Office of Industrial Technologies estimates that by the year 2010 in the industrial sector, the opportunities for savings from improved efficiency in electric motor systems could be roughly as follows: 240 billion kilowatthours per year. $13 billion per year from US industry's energy bill. Up to 50,000 megawatts in new powerplant capacity avoided. Up to 44 million metric tons of carbon-equivalent emissions mitigated per year, corresponding to 3 percent of present US emissions. Recognizing the benefits of this significant opportunity for energy savings, DOE has targeted improvements in the efficiency of electric motor systems as a key initiative in the effort to promote flexibility and efficiency in the way electricity is produced and used. Efficient electric motor systems will help the United States reach its national goals for energy savings and greenhouse gas emission reductions.

6870 (ECN-I–93-038) **An implementation of the diagnosis method DYANA, applied to a combined heat-power device.** Van der Neut, F. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Oct 1993. 84p. Order Number DE94729862. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

The work presented in this report has been performed at the Software Engineering and Research Group at the Netherlands Energy Research Foundation in Petten, Netherlands in order to fulfill the requirements for obtaining the Master's thesis at the State University of Leiden. It is part of the follow-up activities after the ESPRIT project BRA-3178 REFLECT.

The development and implementation of the monitor-and-diagnosis method DYANA is presented. This implementation is applied to and tested on a combined heat and power generating device (CHP). The steps that have been taken in realizing this implementation are evaluated into detail . In chapter two the theory behind DYANA is recapitulated. Attention is paid to the basic theory of diagnoses, and the steps of the path from this theory to the algorithm DYANA are revealed. These steps include the hierarchical approach, and explain the following features of DYANA: a) the use of best-first dynamic model zooming based on heuristics with respect to parsimony of the number of components within the diagnoses, b) the use of consistency of fault models with observations to focus on the most likely diagnoses, and c) the use of online diagnosis: the current set of diagnoses is incrementally updated after a new observation of the system is made. In chapter three the relevant aspects of the system to be diagnosed, the CHP, are dealt with in detail. An explanation is given of the broad working of the CHP, its hierarchical structure and mathematical representation are given, CHP observation is commented, and some possible forms of fault models are stated. In chapter four the pseudocode of the implementation, developed for DYANA, is presented. The pseudocode consists of two parts: the monitoring process (using numerical simulation), and the diagnostic process. The differences between the pseudocode and the actual implementation are mentioned. The CHP will then be monitored and diagnosed with this algorithm and results of this test are given in chapter five. An actual implementation of DYANA can be found in a separately supplied appendix, the Programme Appendix. The implementation of the monitoring process is meant only for this example of the CHP. The code for the diagnostic process can be easily adjusted for diagnosing other devices, such as electronic circuits. The language is Pascal.

6871 (EDF–93-NM-00022) **The influence of falling film heat and mass transfer on the cycle of compression/absorption machines.** Hivet, B. Electricite de France (EDF), 92 - Clamart (France). Dec 1992. 18p. (In French). Order Number DE94728743. Source: OSTI; NTIS (US Sales Only).

We look at the operation of compression/absorption cycle machines in order to produce a high-temperature heat pump. The useful effect of the machine lies in the absorber during absorption of vapour with a high refrigerant content by the solution with a low refrigerant content. We create a thermodynamic model of falling film absorber, which includes a difference at equilibrium. This model involves a mass transfer at the interface, and a heat transfer in the film. Based on this model, we create a global model (with analytical integration) of the transfer equations, a local model (with numerical integration) and an intermediate model. The local model can be used for accurate plotting of the operating curve (the operating curve represents the changing thermodynamic state at the heart of the film). It also enables the calculation assumptions of the global model to be validated, or not. Finally, we perform a parametric study of the local model, which gives more exact information on the operation of the absorber. (author). 3 refs., 12 figs., 3 tabs.

6872 (ETDE-GB–528) **Metal distribution and handling in iron foundries.** Energy Efficiency Office Good Practice Guide Series, no.63. Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom); BCIRA, Birmingham (United Kingdom). 1993. 54p. Order Number DE94730985. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series is designed to offer guidance on ways of improving molten metal handling and distribution techniques, both in existing iron foundries and when planning new facilities, paying particular attention to energy management. (Author)

6873 (ETDE-GB–529) **Reducing energy consumption and costs in small bakeries.** Energy Efficiency Office Good Practice Guide Series, no.64. Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom). 1993. 22p. Order Number DE94730986. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series provides advice on practical ways of improving the energy efficiency of small bakeries. It considers the various system in use, and provides ideas that can either be used with your existing equipment, or to help you choose new plant. (Author)

6874 (ETDE-GB–530) **Electric holding of hot metal in iron foundries.** Energy Efficiency Office Good Practice Guide Series, no.68. Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom); BCIRA, Birmingham (United Kingdom). 1993. 23p. Order Number DE94730987. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series reviews holding plant design and operating procedures affecting the energy consumption per tonne of metal throughput in iron foundries. It reviews the application of holding furnaces, and reviews the factors affecting choice of holding plant. A summary is provided to give the reader a quick reference to the main areas to be considered when contemplating the electric holding of hot metal. (Author)

6875 (ETDE-GB–531) **Continuous steel reheating furnaces: specification, design and equipment.** Energy Efficiency Office Good Practice Guide Series, no.76. Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom); British Steel plc, Rotherham (United Kingdom). Technical Swinden Labs. 1993. 60p. Order Number DE94730988. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series is one of two guides dealing with continuous steel reheating furnaces. This guide provides an introduction to continuous steel reheating furnaces and the basic principles of combustion technology. Furnace design is reviewed, particularly the aspects which affect energy consumption. An action plan is provided which summarises energy-related aspects of furnace design, and reviews the measures which will help reduce energy consumption. (Author)

6876 (ETDE-GB–532) **Continuous steel reheating furnaces: operation and maintenance.** Energy Efficiency Office Good Practice Guide Series, no.77. Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom); British Steel plc, Rotherham (United Kingdom). Technical Swinden Labs. 1993. 40p. Order Number DE94730989. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series and is one of two guides dealing with continuous steel reheating furnaces. This guide considers operation and production aspects, maintenance and monitoring with respect to their effect on energy consumption. Case histories demonstrating good practice for continuous reheating furnaces are included for reference. An action plan is provided which summarises energy-related aspects of operation, and reviews the measures which will help reduce energy consumption. (Author)

6877 (ETDE-GB–533) **Energy efficient liquid ring vacuum pump installations in the paper industry.** Energy Efficiency Office Good Practice Guide Series, no.83. Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom). 1993. 14p. Order Number DE94730990. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series is design to offer guidance on ways of improving liquid ring vacuum pumps, both in existing plant and when planning new facilities, paying particular attention to energy management. (Author)

6878 (ETDE-GB–535) **The pharmaceutical industry.** Energy Efficiency Office Good Practice Guide Series, no.87. Murray (Mike) Technical Services, Pinner (United Kingdom); Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom). 1993. 36p. Order Number DE94730992. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series is designed to offer guidance on ways of improving the efficiency with which energy is used in the UK pharmaceutical industry. It is intended for use by business/site managers and plant/process engineers in all market sectors of the pharmaceutical industry. The Guide points out the main considerations that pharmaceutical manufacturers should take into account when developing an energy strategy, and outlines some of the techniques and methods which can be used to implement such a strategy. Further reading and references are provided to enable more detailed information on methods of saving energy to be obtained. (Author)

6879 (ETDE-GB–536) **Rubber compounding in the rubber processing industry.** Energy Efficiency Office Good Practice Guide Series, no.47. Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom); March Consulting Group, Manchester (United Kingdom). 1993. 53p. Order Number DE94730993. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series is aimed at rubber compounders in the rubber processing industry. Its purpose is to encourage compounders to investigate more closely the possibilities for reducing energy consumption in a cost effective way. A number of case studies are included to illustrate good industry practices in the area of rubber compounding. (Author)

6880 (ETDE-GB–537) **Energy efficient ladle pre-heating techniques within the steel industry.** Energy Efficiency Office Good Practice Guide Series, no.49. Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom); British Steel plc, Rotherham (United Kingdom). Technical Swinden Labs. 1992. 57p. Order Number DE94730994. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series provides advice on practical ways of improving the energy efficiency of ladle preheating techniques in the steel industry. It considers the various ladle heating systems currently used, and gives an action plan which can be applied to existing installations or used for selecting new installations to ensure improved energy use. (Author)

6881 (KCL-KUITU–13) **New possibilities for energy conservation in mechanical pulping.** Sundholm, J. (ed.). Finnish Pulp and Paper Research Inst., Espoo (Finland). 1990. 111p. (In

Finnish). (CONF-9010544–: KUITU seminar on energy efficient mechanical pulping, Espoo (Finland), 17 Oct 1990). Order Number DE94702090. Source: OSTI; NTIS.

FIBRE Research Programme.

The KUITU (energy-efficient mechanical pulping) Research Programme is based on the paper industry's need to improve the quality of mechanical pulp and to reduce energy consumption in mechanical pulping. The ongoing projects were presented at the KUITU Seminar on 17 October 1990 and the topics were the following ones: New process ideas, Enzyme treatment of fibers. Electrical defiberizing of wood. Screening and refining. The effects of grits in the grinding of wood. Phenomena in the grinding zone.

6882 (KCL-KUITU–16) **Energy-efficient manufacture of groundwood and refiner grounwood.** Koskinen, S. Finnish Pulp and Paper Research Inst., Espoo (Finland). 1992. 128p. (In Finnish). (CONF-9112172–: KUITU Seminar on energy efficient mechanical pulping, Espoo (Finland), 12 Dec 1991). Order Number DE94702092. Source: OSTI; NTIS.

FIBRE Research Programme.

The KUITU (energy-efficient mechanical pulping) Research Program is based on the paper industry's need to improve the quality of mechanical pulp and to reduce energy consumption in mechanical pulping. The ongoing projects were presented at the KUITU Seminar on 12 December 1991 and the topics were the following ones: First experiences from a new super-pressure grinding plant. Models for the grinding process. Recent results from pressure grinding research. Direct steam turbine drives. The effect of energy consumption in refining on the quality of refiner groundwood pulp.

6883 (KCP–613-5310) **Assembly flow simulation of a radar.** Rutherford, W.C.; Biggs, P.M. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Oct 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. (CONF-931235–1: NASA 2003 conference, Anaheim, CA (United States), 7 Dec 1993). Order Number DE94002423. Source: OSTI; NTIS; GPO Dep.

A discrete event simulation model has been developed to predict the assembly flow time of a new radar product. The simulation was the key tool employed to identify flow constraints. The radar, production facility, and equipment complement were designed, arranged, and selected to provide the most manufacturable assembly possible. A goal was to reduce the assembly and testing cycle time from twenty-six weeks to six weeks. A computer software simulation package (SLAM II) was utilized as the foundation a for simulating the assembly flow time. FORTRAN subroutines were incorporated into the software to deal with unique flow circumstances that were not accommodated by the software. Detailed information relating to the assembly operations was provided by a team selected from the engineering, manufacturing management, inspection, and production assembly staff. The simulation verified that it would be possible to achieve the cycle time goal of six weeks. Equipment and manpower constraints were identified during the simulation process and adjusted as required to achieve the flow with a given monthly production requirement. The simulation is being maintained as a planning tool to be used to identify constraints in the event that monthly output is increased. "What-if" studies have been conducted to identify the cost of reducing constraints caused by increases in output requirement.

6884 (NEI-DK–1364) **Testing and development of DEF's consultancy concept: Final report.** Ravn, J. Jysk-Fynske Elsamarbejde (ELSAM), Fredericia (Denmark). Distributionsudvalget. Sep 1993. 72p. (In Danish). Order Number DE94730343. Source: OSTI; NTIS.

The Danish electric power company ELSAM evaluated a handbook on energy consultancy published by the Association of Danish Electric Utilities (Danske Elvaerkers Forening) and in particular the "DEF concept" which is a general method recommended to be used in the process of consultancy carried out in industrial firms and which aims at helping them to save energy. The aim of the project was to test the handbook in order to produce a basis for making future adjustments and developments to the book and also to pass on experience gained to energy consultants in Jutland and Funen. Six cases were selected for detailed examination and it was concluded that the concept is a "step-by-step" tool which is both useful and necessary for new energy consultants. It also gives details on reporting requirements. Testing of the concept showed that some firms are sometimes reluctant to explain the finer points of their industrial processes to a consultant which results in the fact that it takes the latter a longer time to understand the processes involved. The DEF concept should constitute a part of the energy survey, not the whole. It is important that involved parties are generally more familiar with the concept, its implementation should increase, follow-up should take place, information gained should be recorded centrally and more attention should be given to smaller firms. The papers related to the six cases selected for examination are presented. (AB)

6885 (NEI-DK–1389) **Optimization of energy efficiency in relation to digital electric drive systems.** Energiministeriets Forskningsprogram. Energianvendelse i erhvervslivets processer og produkter, Energiministeriets Forskningsprogram. Energianvendelse i erhvervslivets processer og produkter. Leutenberger, P. Danmarks Ingenioerakademi, Lyngby (Denmark). Elektroafdelingen. Nov 1992. 65p. (In Danish). Contract ENS-1223/90-0008. Order Number DE94730335. Source: OSTI; NTIS.

EFP-90.

Various methods are described for minimizing the energy consumption of electric drive systems. The theoretical background for optimization of the efficiency level at stationary workpoints in shunt-type direct-current motors is briefly described. Measurements and calculations have shown that the degree of efficiency can be increased by 0-25%, dependent on the workpoint. The improvement continues with decreasing moment and number og revolutions. The theoretical basis for minimizing energy consumption at stationary workpoints with regard to induction machines controlled by frequency formers is also explained. Here the degree of efficiency can be improved up to 20%, dependent on the workpoint and improvement also continues in accordance with decreasing moment and number of revolutions. A method was developed for estimating the impedance of induction machines based on catalogued data. The method makes it possible to implement the open loop minimization of the energy consumption of the induction machine and can be generally used where knowledge of the relevant data is necessary. The theory for optimal regulation is described and used to determine the velocity profile for a direct-current motor. Calculations show that the degree efficiency can be improved by 12% by use of the optimal profile instead of the traditional trapeze profile. (AB)

6886 (NREL/CP–200-5768-Vol.1, pp. 156-161) **Managing woodwaste: Yield from residue.** Nielson, E. (LNS Services, Inc., North Vancouver, British Columbia (Canada)); Rayner, S. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Historically, the majority of sawmill waste has been burned or buried for the sole purpose of disposal. In most jurisdictions, environmental legislation will prohibit, or render uneconomic, these practices. Many reports have been prepared to describe the forest industry's residue and its environmental effect; although these help those looking for industry-wide or regional solutions, such as electricity generation, they have limited value for the mill manager, who has the on-hands responsibility for generation and disposal of the waste. If the mill manager can evaluate waste streams and break them down into their usable components, he can find niche market solutions for portions of the plant residue and redirect waste to poor/no-return, rather than disposal-cost, end uses. In the modern mill, residue is collected at the individual machine centre by waste conveyors that combine and mix sawdust, shavings, bark, etc. and send the result to the hog-fuel pile. The mill waste system should be analyzed to determine the measures that can improve the quality of residues and determine the volumes of any particular category before the mixing, mentioned above, occurs. After this analysis, the mill may find a niche market for a portion of its woodwaste.

6887 (NREL/CP–200-5768-Vol.2, pp. 1259-1277) **Bonding exterior grade structural panels with copolymer resins of biomass residue components, phenol, and formaldehyde.** Chen, C.M. (Univ. of Georgia, Athens, GA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Components of various forest and agricultural residue biomass-including the polyphenolic compounds-were converted into aqueous solution and/or suspension by extraction and digestion. Some biomass components reacted vigorously under alkaline catalysis with formaldehyde and initially showed a high degree of exothermic reaction; however, other components did not react as vigorously under these conditions, indicating that different biomass materials require different methods to obtain optimum reactivity for the copolymerization with phenol. Our primary goal is to develop adhesives capable of producing acceptable bond quality, as determined by the wood products industries' standards, under a reasonable range of gluing conditions. Copolymer resins of phenol, formaldehyde, and biomass components were synthesized and evaluated for gluability of bonding exterior grade structural replaced with chemicals derived from peanut hulls, pecan shell flour, pecan pith, southern pine bark, and pine needle required shorter press times. These resins also tolerated a broader range of gluing conditions. In summary, it appears that the technology of the fast curing copolymer resins of biomass components as adhesives for wood products has been developed and is ready to be transferred to industrial practice.

6888 (NREL/CP–200-5768-Vol.2, pp. 1278-1291) **Metal mediated transformations of lignin models. Preparation of benzoquinones as chemical intermediates.** Bozell, J.J. (National Renewable Energy Lab., Golden, CO (United States)); Hames, B.R. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States). 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The efficient conversion of renewable materials into useful chemicals is an important component of a program to introduce biomass as a viable raw material for the chemical industry. We have been investigating lignin as a starting material for producing benzoquinones, compounds used in the dye industry and as bioactive materials. We are developing methods for the selective oxidation of the electron rich aromatic units that make up the lignin structure to prepare benzoquinones by investigating the reaction of compounds that model lignin's behavior. We find that oxygen in the presence of Co catalysts oxidized several of these model compounds to the corresponding benzoquinone in high (>80%) yield. The efficiency of the oxidation depends strongly on the structure of the lignin model, the catalyst, and the reaction conditions. Results of the study and a mechanistic rationale are presented.

6889 (NREL/CP–200-5768-Vol.2, pp. 1292-1297) **Wood as a feedstock for activated carbons.** Jagtoyen, M. (Univ. of Kentucky, Lexington, KY (United States)); Derbyshire, F. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Activated carbons are used in a wide range of applications, including the improvements of air and water quality, and are generally of interest for the resolution of environmental problems. Wood is a common feedstock for activated carbon production by reaction with phosphoric acid at temperatures in the range 350–450°C. The extended use of wood for the production of high added-value productions could improve the use of this resource, and present solutions to the problems of the disposal of wood wastes. Little information exists in the public sector on the mechanisms of the synthesis process, the factors that influence the development of porosity and adsorptive properties, and how these relate to the structure of the starting material. As part of an on-going research program, the conversion of white oak to activated carbons by reaction with phosphoric acid has been investigated. It has established for the first time, a link between the origins of porosity and reaction mechanisms. It is concluded that porosity development is a consequence of the retention and dilation of cellular material which creates an extensive surface accessible to adsorbent molecules. The results may be relevant to understanding equivalent processes with other biomass and coal precursors that contain biopolymers or altered biopolymers.

6890 (NREL/CP–200-5768-Vol.2, pp. 1298-1304) **Catalytic conversion of lactic acid and its derivatives.** Kokitkar, P.B. (Michigan State Univ., East Lansing, MI (United States)); Langford, R.; Miller, D.J.; Jackson, J.E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The catalytic upgrading of lactic acid and methyl lactate is being investigated. With the commercialization of inexpensive starch fermentation technologies, US production of lactic acid is undergoing a surge. Dropping cost and increased availability offer a major opportunity to develop lactic acid as a renewable feedstock for chemicals production. IT can be catalytically converted into several important chemical intermediates currently derived from petroleum including acrylic acid, propanoic acid, and 2,3-pentanedione. The process can expand the potential of biomass as a substitute feedstock for petroleum and can benefit both the US chemical process industry and US agriculture via increased production of high-value, non-food products from crops and crop byproducts. Reaction studies of lactic acid and its ester are conducted in fixed bed reactors at 250-380°C and 0.1-0.5 MPa (1-5 atm) using salt catalysts on low surface area supports. Highest selectivities achieved are 42% to acrylic acid and 55% to 2,3-pentanedione from lactic acid over $NaNO_3$ catalyst on low surface area silica support. High surface area (microporous) or highly acidic supports promote fragmentation to acetaldehyde and thus reduce yields of desirable products. The support acidity gives rice to lactic acid from neat methyl lactate feed but the lactic acid yield goes down after the nitrate salt is impregnated on the support. Both lactic acid and methyl lactate form 2,3-pentanedione. Methyl lactate reactions are more complex since it forms all the products obtained from lactic acid as well as many corresponding esters of the acids obtained from lactic acid (mainly methyl acrylate, methyl propionate, methyl acetate). At high temperatures, methyl acetate and acetic acid yields become significant from methyl lactate whereas lactic acid gives significant amount of acetol at high temperatures.

6891 (NREL/CP–200-5768-Vol.2, pp. 1305-1310) **Production of low-cost calcium magnesium acetate (CMA) as an environmentally friendly deicer from cheese whey.** Yang, S.T. (Ohio State Univ., Columbus, OH (United States)); Zhu, H.; Li, Y.; Tang, I.C. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

About 28 billion lbs of cheese whey are being wasted in the US because of the high biological oxygen demand (BOD) of whey, disposing of surplus whey is a pollution problem. An innovative, wide-scale solution to the whey disposal problem is to use whey as a zero- or low-cost feedstock for the production of an environmentally safe, noncorrosive, road deicer-calcium magnesium acetate (CMA). CMA can be used to replace some of the 10 to 14 million

tons road salt used in the North America for deicing. A novel anaerobic fermentation process is developed to produce calcium magnesium acetate (CMA) from whey permeate. A co-culture consisting of homolactic (S. lactis) and homoacetic (C. formicoaceticum) bacteria was used to convert whey lactose to lactate and then to acetate in continuous, immobilized cell bioreactors. The acetate yield from lactose was ~95% (wt/wt), and the final concentration of acetic acid was 4%. The acetic acid present in the fermentation broth can be recovered by solvent-extraction with a tertiary amine and reacted with dolomitic lime (Ca/MgO) to form a concentrated (>25%) CMA solution. About 25 tons CMA can be produced from a plant processing 1 million lbs whey permeate (4.5% lactose) per day. The production costs are estimated at ~$220/ton CMA, which is only about one third of the present market price for CMA deicer. Therefore, about 0.8 million tons/yr CMA deicer can be produced from the currently unused whey. This will partially fulfill market demand for economically and environmentally sound chemicals for roadway deicing. This also will provide a viable solution to the whey disposal problem currently facing many dairies in the North America.

6892 (NREL/CP–200-5768-Vol.2, pp. 1311-1319) **Study of lignocellulose components for production of lactic acid.** Padukone, N. (National Renewable Energy Lab., Golden, CO (United States)); Schmidt, S.L.; Goodman, B.J.; Wyman, C.E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Lactic acid promises to be an important chemical feedstock in the future for the production of biodegradable and biocompatible polymers. About half of the current US consumption is imported to meet the escalating demand from both the food and chemical industries. The potential future market for polylactide products would further stress the domestic capacity of lactic acid production. Renewable resources such as lignocellulosic crops and wastes are abundant and could be utilized for the production of important fuels and chemicals. This would not only reduce our dependence on limited reserves of fossil fuels but also alleviate the environmental burden of waste accumulation and disposal.

6893 (NREL/CP–200-5768-Vol.2, pp. 1320-1325) **Fractionation of lignocellulosic biomass components by prehydrolysis-organosolv delignification.** Papatheofanous, M.G. (National Technical Univ. of Athens (Greece)); Koullas, D.P.; Koukios, E.G.; Billa, E.; Monties, B. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Based on economic, environmental and other considerations the feasibility of converting lignocellulosics to chemicals and other industrial products could be significantly enhanced if all major components, that is cellulosic fibers, hemicellulosic polymers and lignin could be efficiently utilized. Such a two stage process scheme under investigation by this group consists of a mild hydrolytic treatment fractionating hemicelluloses as high purity sugar solutions, followed by acid- or alkali-catalyzed low temperature organosolv delignification aiming at the production of a high quality cellulosic pulp and high reactivity lignin-derived oligomers. Results reports here concern the effects of selective hemicellulose fractionation (between 0% and 90%) and variable delignification conditions (catalytic system, ethanol: water ratio) on the pulping stage, using wheat straw as raw material. Pulp yield, degree of delignification, mechanical properties of handsheets and lignin structure are compared to those of conventional pulping. Optimal pulp properties are obtained following saccharification of about 50% of hemicelluloses whereas a somewhat lower degree of fractionation is required to avoid significant condensation reactions in lignin. Although organosolvents rich in ethanol are more selective towards delignification and cellulose degradation is then limited, their pulping ability decreases at low water content, i.e. less than 35% v/v. The combination of alkali and ethanol is vital for the production of pulps with low Kappa Numbers (40).

6894 (NREL/CP–200-5768-Vol.2, pp. 1385-1408) **The thermochemical conversion of cellulosic biomass to high value chemicals and fuel additives.** Fitzpatrick, S.W. (Biofine Inc., Wellesley, MA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

This paper describes the Biofine Process technology for conversion of low grade cellulosic biomass waste to levulinic acid. Levulinic acid is a highly versatile chemical intermediate which can be converted directly into a range of high value and commodity chemicals. Advantages of the Biofine process are discussed including low production costs, high yields, and versatility of feedstock. A description of the technology is provided and a summary of the possible feedstocks including paper mill wastes, sewage sludge, wood wastes, waste paper, and agricultural wastes. Descriptions of the products of this technology are given including delta amino levulinic acid, methyl tetrahydrofuran, diphenolic acid and others.

6895 (NREL/CP–200-5768-Vol.2, pp. 1416-1426) **Using biosolids from agricultural processing as food for animals.** Belyea, R.L. (Univ. of Missouri, Columbia, MO (United States)); Clevenger, T.E.; Van Dyne, D.L.; Eckhoff, S.E.; Wallig, M.A.; Tumbleson, M.E. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

A diverse inventory of secondary products arise from processing of agricultural commodities. Societal, economic and physical constraints will curtail traditional disposal methods and create a need for alternatives that conserve, recycle and capitalize on these underutilized resources. Economic viability of some processes or primary products may depend upon practical alternatives for disposing of secondary products. The broad nature of secondary products and the process from which they emanate along with the complex transformations needed for remediation will require the efforts of multidisciplinary teams of scientists to identify creative solutions. Most secondary products have significant nutritional value and could be fed to animals as a means of disposal. However, detailed chemical and biological characterization is needed to determine nutrient concentrations and to ensure safety and efficacy. Feeding studies will be necessary to demonstrate palatability and to determine effects upon animal health and performance. New bioprocessing techniques will be needed to remediate the attributes of some secondary products into more appropriate forms or qualities. The potential for using wash water biosolids as animal food was investigated. Wash water biosolids from a broad cross section of food processing plants were found to be free from pollutants and other harmful entities. Nutrient composition varied considerably within and among different types of food processing plants (i.e., milk vs poultry). However, within a particular plant, variation in mineral concentration of biosolids over several months was quite small. Wash water biosolids from a milk processing plant were found to be free of pollutants and to have nutritional value. Diets containing biosolids were palatable when fed to sheep, cows, turkeys, or swine. Safety and efficacy studies with sheep and swine indicated that feeding up to 20% biosolids did not adversely affect growth, reproduction or survival.

6896 (NUTEK-VK–93-17) **Kalina cycles for power generation from industrial waste heat.** Olsson, Eva (Royal Inst. of Tech., Stockholm (Sweden). Dept. of Heat Technology); Thorin, E.; Svedberg, G. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). Mar 1993. 20p.

Project NUTEK-566-024. Order Number DE94730431. Source: OSTI; NTIS.

The aim of this study is to investigate the possibilities to produce power from industrial waste heat, using cycles with non-azeotropic ammonia-water mixtures. In this study, some simple Kalina cycle designs have been calculated for applications of industrial waste heat and moderate temperature, about 300-400 degrees C, from gas streams in the iron and steel industry or elsewhere. Calculations on cycle efficiency have been carried out for application in which the Kalina cycle works as a condensing cycle and also others, on which it provides heat for process streams. The results show that a Kalina cycle is a more efficient condensing power cycle than the Rankine cycle for this kind of waste heat. The first law cycle efficiency varies with the heat source inlet and minimum temperature and is 22-30% for the Kalina cycle and 16-29% for the Rankine cycle. The analysis of the two cases in which the power cycle provides heat for process streams shows that Kalina cycle technology can be used for this kind of application. A Kalina cycle can be modified to work as a back pressure cycle with or without a condensing tail. In the latter case, the modified Kalina cycle can produce power with what can be regarded as an efficiency of 96%, i.e. the ratio between power production and extra heat demand for the system. The extra degree of freedom that the Kalina cycle has because of its possibility to vary the composition can be used to adjust the cycle to variations in heat source conditions with preserved cycle efficiency. The Kalina cycle can also take advantage of low ambient temperature much better than the Rankine cycle. The principal reasons for these advantages and the potential for high efficiencies are the non-isothermal boiling and condensation and the possibility to vary the composition. 11 refs, 9 figs, 3 tabs

6897 (PNL-SA-23361) **Chemi-microbial processing of waste tire rubber: A project overview.** Romine, R.A.; Snowden-Swan, L. Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931241--1: Pollution prevention technologies: industry exchange workshop, San Antonio, TX (United States), 1-3 Dec 1993). Order Number DE94004781. Source: OSTI; NTIS; INIS; GPO Dep.

PNL is developing a method to use thiophillic microorganisms to devulcanize (biodesulfurize) the surface of ground rubber particles, which will improve the bonding and adhesion of the ground tire rubber into the virgin tire rubber matrix. The Chemi-microbial processing approach, introduced in this paper, is targeted at alleviating the waste tire problem in an environmentally conscious manner; it may also be applied to improve asphaltic materials and rubber and polymeric wastes to facilite their recycling. This paper outlines the logic and technical methods that will be used.

3206 Municipalities and Community Systems

Refer also to citation(s) 6369, 6374, 6407, 6443, 6805, 6821, 6825, 6956

6898 (ENEA-RT-ENERG-92-02) **Technical and economical feasibility study for energy re-qualification of school buildings in Bertesina 'M. Montessori', Vicenza (Italy).** Michelini, M. (ENEA, Casaccia (Italy). Area Energetica); Minischetti, M.; Parutto, R.; Porfiri, M.T.; Trevisan, F. No corporate text available. Apr 1993. 155p. (In Italian). (RT/ENERG-92-02). Order Number DE94727311. Source: OSTI; NTIS (US Sales Only).

Educational buildings have been object of several activities by ENEA (Italian National Agency for New Technology, Energy and Environment), referring to the possibilities of energy saving in accordance with the comfort and the hygiene regulations provided by the law (see Acta of the seminar: 'Interventi di miglioramento energetico nelle scuole', Roma, 26-27 ottobre 1989). The present work is the first concrete experience of collaboration with a municipal enterprise (AMCPS) which manages the school buildings of the Municipality of Vicenza. In particular, we have analyzed the interventions on the building envelope (substitution of windows and doors, insulations by modern technics, elimination of old dampers for ventilation, installation of heat regenerator from exhausted air, improvements on lighting sources, etc.) and on the heating plant and hot water production (substitution of old boilers with high efficiency boilers, reduction of thermal losses from piping, etc.). These actions have been defined on the basis of an extensive acquisition data about the comfort within some schools whose heating plant is managed by AMCPS.

6899 (LUTMDN-TMVK-5224) **The principles of ISO 9000 and quality assurance applied to district heating networks - a study performed at Lunds Energiverk, Sweden, and Fernwaerme Greifswald GmbH, Germany.** Penderos, M. Lund Univ. (Sweden). Dept. of Heat and Power Engineering. Sep 1993. 60p. Order Number DE94730446. Source: OSTI; NTIS.

This master thesis presents an attempt to make the principle of quality assurance understandable in district heating contexts. The district heating networks in Lund and in Greifswald are chosen to illustrate the quality conception. District heating could generally be looked upon as a service and therefore the quality aspects are to be discussed in such a context. A key variable is a quality indicator that gives information about the product or service to be controlled. As key variable concerning the consumers controlling functions, the importance of good customer contact and key factors as numbers of interruptions and the duration of the interruptions are chosen. Then there are key variables concerning the distribution net and the district heating plants. As key variables concerning the organization the distribution of responsibility and the managements responsibility for the accomplishment is looked upon. From interviews it was found that the heat exchanger, the flow through it and the temperature fall over it, was very important. Educating the real estate attendants so that simpler adjustments can be done on a regular basis, is to raise the delivery quality. The importance of good customer-contact is also raised. 73 refs

6900 (NEI-DK-1355) **Pulsating district heating with single pipeline network system.** Energiministeriets Forskningsudvalg for produktion og fordeling af el og varme. Fjernvarme og produktion af el og varme, Energiministeriets Forskningsudvalg for produktion og fordeling af el og varme. Fjernvarme og produktion af el og varme. Astrupgaard, N.P. Dk-TEKNIK, Soeborg (Denmark). Energi og Miljoe. May 1993. 39p. (In Danish). Contract ENS-1323/90-0013. Order Number DE94730215. Source: OSTI; NTIS.

EFP-90.

The aim was to investigate the potentials for reducing the cost of a new district heat distribution network by introducing a single pipeline system comprising long stretches of pipe without joints running from house to house so that underground joints are avoided. In each house a 300 liter accumulator tank is charged in turn as a hot pulse spreads around the network so that the cold water in the pipes from the individual consumer is continually pushed forward in front of the hot pulse. A computerized simulation showed that this form of operation could be feasible if the hot pulse is well-defined and if there is a distance of less than 600 meters to the first consumer. The amount of heat loss from flexible plastic pipes with flexible polyurethane foam insulation is reckoned to be 50% more than claimed by the manufacturer. In the case of a single pipeline system the heat loss in the district heating distribution network could be reduced by more than 50% as operation is constantly optimal. It is suggested that consumer installations comprising twin pipes running from house to house without underground joints, with a traditional operation, can be initiated at a cost 25% cheaper than a network with steel pipes. Here heat losses could be reduced by 15%. The single pipeline network would be ca. 5% cheaper than a similar network in steel, and would lead to a halving of heat losses (from 93 MWh/yr to ca. 40 MWh/yr in a network with 27 consumers). It is recommended to adopt the twin-pipe system where it should be possible to change from traditional to a single pipeline operation with parallel flow. (AB) (12 refs.)

6901 (NEI-DK-1368) **District heating in Denmark: Research and technological development.** Oester, F. (ed.). Energistyrelsen, Copenhagen (Denmark). 1993. 56p. Order Number DE94730318. Source: OSTI; NTIS.

The document, published by the Danish Energy Agency (under the Ministry of Energy) comprises a collection of articles related to district heating in Denmark contributed by persons employed in leading positions in Danish firms institutes and associations who are specialists on this subject. Topics dealt with are the design and

development of district heating systems, pollution abatement, cogeneration of power and heat, fuel flexibility, low temperature operation, components and transmission systems, consumer connections, renovation and maintenance, economy and administration and future technologies. A list of relevant companies and organizations is given. The publication is richly illustrated with coloured photographs, maps, diagrams, graphs and tables. (AB)

6902 (NEI-DK–1368, pp. 18-21) **Principles of combined heat and power generation.** Olsen, F.A. (Danish Power Consult A/S (Denmark)). Energistyrelsen, Copenhagen (Denmark). 1993. In *District heating in Denmark: Research and technological development.* 56p. Order Number DE94730318. Source: OSTI; NTIS.

The utilisation of heat produced in combination with electricity is related to the impossibility of converting thermal energy into mechanical or electric energy without considerable losses. For modern coal-fired power stations of 200-600 MW using seawater as coolant, the maximum conversion efficiencies obtainable will be no better than about 45%. And these levels could be realised only at steam pressures as high as 240 bar, temperatures of 560 deg. C, and a single reheat of steam. The use of natural gas in a combined cycle power plant makes it possible to increase the maximum efficiency to approx. 50% due to the higher temperature of the working medium. In a combined cycle plant a gas turbine is placed before a boiler producing steam to operate a steam turbine. The higher the temperature of the working medium (gas or steam) and the lower the temperature of the coolant in producing mechanical energy in a turbine or combustion engine, the higher the output of mechanical energy or electricity. These are important factors when considering combined heat and power systems where the coolant is the district heating water. The advantages of combined heat and power production are illustrated by comparing the operation of three types of power plants and illustrating their design. The principles underlying large-scale plants based on condensing, back pressure, extraction and combined cycle and small-scale cogeneration plants based on combustion-type engines, gas turbines, combined-cycle and those that can be fueled with biomass fuels or coal are explained. The system design and optimization of a cogeneration system is described in addition to the development trend of higher electric efficiency and higher C_M value in three types of cogeneration plants - based on combustion engines, back pressure and gas turbines respectively. (AB)

6903 (NEI-DK–1368, pp. 32-34) **Low-temperature district heating.** Andersen, N.B. (Centre for District Heating Technology, Danish Technological Institute (Denmark)). Energistyrelsen, Copenhagen (Denmark). 1993. In *District heating in Denmark: Research and technological development.* 56p. Order Number DE94730318. Source: OSTI; NTIS.

Concise information is given on the current status of low-temperature district heating in Denmark, illustrated by statistical data and photographs of components and equipment. (AB)

6904 (NEI-DK–1368, pp. 38-42) **Distribution system and consumer connections.** Bryder, K.L. (Centre for District Heating Technology, Danish Technological Institute (Denmark)). Energistyrelsen, Copenhagen (Denmark). 1993. In *District heating in Denmark: Research and technological development.* 56p. Order Number DE94730318. Source: OSTI; NTIS.

The Danish district heating heat distribution system and consumer connections are described in detail and the design is illustrated with diagrams and photographs of components. (AB)

6905 (NREL/CP–200-5768-Vol.1, pp. 341-346) **Integrated solid waste management in Japan.** Cohen, A.S. (CSI Resource Systems, Boston, MA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

The Japanese, through a combination of public policy, private market conditions, and geographic necessity, practice integrated municipal solid waste management as defined by the US Environmental Protection Agency. The Japanese have not defined a specific hierarchical preference for alternative waste management practices, i.e., waste reduction, reuse and recycling, combustion, composting, and landfill disposal. However, in marked contrast to the US approach, the Japanese system relies heavily on waste combustion, with and without energy recovery. "Discards", as the term is used in this paper, refers to all materials considered used and spent by residential and commercial generators. That which is discarded (whether recyclable or nonrecyclable) by a municipality is referred to as MSW. This paper provides an overview of MSW management practices and private-sector recycling in Japan. Estimates of the total generation of residential and commercial discards and their disposition are also presented. Such an overview of Japanese practices can be used to assess the potential effectiveness of US integrated solid waste management programs. Of the estimated 61.3 to 72.1 million tons of residential and commercial discards generated in Japan during its 1989 fiscal year (April 1, 1989, through March 31, 1990), an estimated 55 to 64 percent was incinerated; 15 to 28 percent was recycled (only 2 to 3 percent through municipal recycling activities); less than 0.1 percent was composted or used as animal feed; and 17 to 20 percent was landfilled. Including ash disposal, 26 to 30 percent, by weight, of the gross discards were landfilled.

6906 (NREL/CP–200-5768-Vol.1, pp. 621-633) **The R.D.F. gasifier of Florentine area.** Barducci, G. (Studio Tecnico di Ingegneria Ambientale, Firenze (Italy)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

L.E.G. (Low Energy Gas) from large biomass gasification plants, to be used as a fuel for electricity production, is a suitable means for adding value – from an energetic point of view – to the R.D.F. (Refuse Derived Fuel) and to the agricultural and forestry residues. R.D.F. can be converted to a clean gas turbine fuel by gasification that consists in a partial combustion with oxygen or air and steam. In that sense it seems worthwhile to analyze the capacity of a gasifier such as the Greve in Chianti's recirculating fluidized bed gasifier. The world's first full-scale R.D.F. gasification plant has been designed in Florence; it is now realized in Greve in Chianti and, at the moment, is starting the industrial management. The plant is designed to gasify 200 t/d of pelletized R.D.F. producing about 17.000/19.000 Nmc/h of low energy gas (LEG) with a net calorific value (NCV) of about 5 MJ/Nmc and a total energy content (at the outlet of the gasifiers) of about 7.5 MJ/Nmc. The produced LEG will be partly burned on site for power production while partly will be cooled, dedusted and transported to the kiln of the adjacent cement factory. The design idea of R.D.F. gasification starts from field of waste treatment and recycling and develops new, advanced technical and economical sinergy with the field of industrial production and electric power generation. The gasification of fuels derived from selected wastes (and/or industrial refuse) and the exploitation of the lean gas produced is the most advanced point in the development of heat conversion processes.

6907 (NREL/CP–200-5768-Vol.2, pp. 964-977) **MSW and biomass to liquid fuels by packaged liquefaction plants.** Joyner, H.S. (Waste Resources Recovery, Inc., Wichita, KS (United States)); Vaughan, B.M.; White, D.H.; Wolf, D. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

An extruder-feeder biomass liquefaction process under DOE-sponsorship was developed at the Univ. of Arizona in the 1980s to produce liquid fuels as an alternative energy source. Since 1988, the work has been redirected toward organic solid wastes, particularly MSW, but with the production of by-products to enhance the economics. The technology is being transferred to the private sector, with emphasis on major reductions of wastes to landfills.

Modular liquefaction plants can reduce wastes to landfills by 70 to 80 percent, compared to about 20 percent by recycling and some local composting alone. The process lends itself for small to medium-sized packaged plants that can be expanded from the basic 200 ton per day unit to 400 tons per day, and then later on to 800 tons per day. Some economic advantages can be achieved by (a) integration with a mini-MRF (materials recovery unit), and (b) modest amount of composting. Current research involves (a) the use of a light fraction of these oxygenated liquefaction products as a diesel fuel additive and (b) the formulation of a heavy fraction with recycled rubber and plastics for pavement asphalts. The overall economics appear attractive.

6908 (NREL/CP-200-5768-Vol.2, pp. 978-992) **Light hydrocarbon liquids from dry raw sewage sludge.** Boocock, D.G.B. (Univ. of Toronto, Ontario (Canada)); Konar, S.K.; Liu, J.; Bahadur, N.; Leung, A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106--Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Technology has been developed outside our group for the direct liquefaction of dry raw sewage sludge. However, the product is a fairly viscous, unpleasant-smelling liquid which contains up to 8% nitrogen and 2.5% sulphur, precluding its use as a fuel. Polar groups associated with these elements and oxygen also cause emulsification with pyrolytic water. We have identified that most nitrogen and sulphur-free oil derives from the lipid fraction and that nitrogen and sulphur-containing oil derives from the protein. Toluene extraction of a raw sewage sludge gives 18 wt % of lipid, and rejects 99% and 84% of the nitrogen and sulphur respectively. The extract contains 14–16% oxygen. The lipid contains 65% carboxylic acids, 7% glycerides and 28% unsaponifiables. Catalytic pyrolysis of the lipid over activated alumina at 450°C at a weight hourly space velocity less than 0.6 yields a light hydrocarbon liquid which contains 25% of the original carbon in the sludge. There is a fairly uniform distribution of compounds across the C6 to C20 range with a preference for unbranched compounds. The catalytic pyrolysis results in deoxygenation of carboxylic acids, esters and possibly some intermediate ketones.

6909 (PNL–8930) **Estimate of federal relighting potential and demand for efficient lighting products.** Shankle, S.A.; Dirks, J.A.; Elliott, D.B.; Richman, E.E.; Grover, S.E. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004568. Source: OSTI; NTIS; GPO Dep.

The increasing level of electric utility rebates for energy-efficient lighting retrofits has recently prompted concern over the adequacy of the market supply of energy-efficient lighting products (Energy User News 1991). In support of the U.S. Department of Energy's Federal Energy Management Program, Pacific Northwest Laboratory (PNL) has developed an estimate of the total potential for energy-efficient lighting retrofits in federally owned buildings. This estimate can be used to address the issue of the impact of federal relighting projects on the supply of energy-efficient lighting products. The estimate was developed in 1992, using 1991 data. Any investments in energy-efficient lighting products that occurred in 1992 will reduce the potential estimated here. This analysis proceeds by estimating the existing stock of lighting fixtures in federally owned buildings. The lighting technology screening matrix is then used to determine the minimum life-cycle cost retrofit for each type of existing lighting fixture. Estimates of the existing stock are developed for (1) four types of fluorescent lighting fixtures (2-, 3-, and 4-lamp, F40 4-foot fixtures, and 2-lamp, F96 8-foot fixtures, all with standard magnetic ballasts); (2) one type of incandescent fixture (a 75-watt single bulb fixture); and (3) one type of exit sign (containing two 20-watt incandescent bulbs). Estimates of the existing stock of lighting fixtures in federally owned buildings, estimates of the total potential demand for energy-efficient lighting products if all cost-effective retrofits were undertaken immediately, and total potential annual energy savings (in MWh and dollars), the total investment required to obtain the energy savings and the present value of the efficiency investment, are presented.

3209 Education and Public Relations

Refer also to citation(s) 6777, 6878

6910 (DOE/ER/75640–1) **Austin Children's Museum "Go Power" project: Final report.** Austin Children's Museum, TX (United States). Oct 1993. 79p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER75640. Order Number DE94004925. Source: OSTI; NTIS; GPO Dep.

Go Power, was conceived as an interactive exhibit and related set of activities designed to promote in children and families an understanding and appreciation of energy concepts. Planned in 1990, the project culminated its first phase of activities with colorful, interactive exhibit about the pathways and transformations of energy, on display at the Austin Children's Museum between February 5th and June 6th, 1993. The project was supported by the US Department of Energy, the National Science Foundation, the Lower Colorado River Authority and various local foundations and businesses. This report describes the process, product and outcomes of this project.

6911 (ETDE-GB–534) **Managing and motivating staff to save energy.** Energy Efficiency Office Good Practice Guide Series, no.84. Grafton Interaction, London (United Kingdom); MCR Energy, London (United Kingdom); Department of Energy, London (United Kingdom). Energy Efficiency Office; Energy Technology Support Unit, Harwell (United Kingdom). 1993. 39p. Order Number DE94730991. Source: OSTI; NTIS (US Sales Only).

This booklet in the Good Practice Guide Series aims to show the important part that people play in managing energy. It emphasises that energy is a management issue and offers guidance on how to start an energy saving campaign, with particular advice on how to motivate staff to save energy. Some case histories are included to show how other companies have managed their campaigns, to provide both suggestions and encouragement. (Author)

33 ADVANCED PROPULSION SYSTEMS

Refer also to citation(s) 6326, 7136

6912 (UCRL–52000-93-7) **Energy and technology review, July 1993.** Quirk, W.J. Lawrence Livermore National Lab., CA (United States). Jul 1993. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004219. Source: OSTI; NTIS; GPO Dep.

This report discusses the two-stage light-gas gun which was developed by the Super-High-Altitude Research Project (SHARP) is a step toward realizing a launcher that can do this at a fraction of the cost of rockets. The SHARP gun is different from other two-stage designs because it is larger and its launch and pump tube are joined at right angles. This configuration allows the launch tube to point at any angle toward the sky while the pump tube remains horizontal. We have demonstrated that this gun can fire projectiles when the launch tube is in the horizontal position. Dr. Michael M. May who was the Laboratory's fifth Director (1965–71) and is now a Director Emeritus. Under his directorship, the groundwork was laid for the Laboratory's Energy Program, environmental science programs, and Laser Program. May remains active in research on arms control, nonproliferation, and cooperative security, and he is doing research and teaching at UC San Diego and at Stanford University. As part of the Laboratory's 40th anniversary celebration, May was invited to lecture on his views of the changing world and the role of LLNL. In 1992, he participated in an influential National Academy of Sciences study on the reduction of nuclear weapons. This study recommended that the US cut strategic weapons to one-third the present number, withdraw most tactical weapons, and dismantle the retired nuclear weapons. May is convinced that the relative stability now present among the major nations is a precondition for keeping the demand for nuclear weapons low among the nuclear "have-not" nations. In the coming years, May believes that the Laboratory will remain most useful at major government-funded

R&D projects in the areas of defense, energy, and the environment. May is now working on a new report on the disposition of surplus plutonium from nuclear weapons.

3301 Internal Combustion Engines

Refer also to citation(s) 6066, 6460, 6572, 6577, 6578, 6916, 7034, 7916

6913 (DOE/MC/23174–94/C0246) **Coal-fueled diesel engines for locomotive applications.** Hsu, B.D.; Najewicz, D.J.; Cook, C.S. General Electric Co., Erie, PA (United States). Transportation Systems Business Operation. [1993]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-88MC23174. (CONF-930893–26: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94002972. Source: OSTI; NTIS; GPO Dep.

GE Transportation Systems (GE/TS) completed a two and one half year study into the economic viability of a coal fueled locomotive. The coal fueled diesel engine was deemed to be one of the most attractive options. Building on the BN-NS study, a proposal was submitted to DOE to continue researching economic and technical feasibility of a coal fueled diesel engine for locomotives. The contract DE-AC21-85MC22181 was awarded to GE Corporate Research and Development (GE/CRD) for a three year program that began in March 1985. This program included an economic assessment and a technical feasibility study. The economic assessment study examined seven areas and their economic impact on the use of coal fueled diesels. These areas included impact on railroad infrastructure, expected maintenance cost, environmental considerations, impact of higher capital costs, railroad training and crew costs, beneficiated coal costs for viable economics, and future cost of money. The results of the study indicated the merits for development of a coal-water slurry (CWS) fueled diesel engine. The technical feasibility study examined the combustion of CWS through lab and bench scale experiments. The major accomplishments from this study have been the development of CWS injection hardware, the successful testing of CWS fuel in a full size, single cylinder, medium speed diesel engine, evaluation of full scale engine wear rates with metal and ceramic components, and the characterization of gaseous and particulate emissions.

3302 External Combustion Engines

Refer also to citation(s) 6829

6914 (LUTMDN-TMVK–7014) **A study of a low emission combustor - lean premix prevaporize concept.** Nilsson, Johan. Lund Univ. (Sweden). Dept. of Heat and Power Engineering. Nov 1993. 58p. Order Number DE94730447. Source: OSTI; NTIS.

This thesis deals with the Lean Premix Prevaporize combustors for stirling and steam engines. The objective of this study has been to show that low-emission potential and the practical use of the combustor concept in these applications, and also to give some basic understanding of combustion generated emissions. Two combustors have been investigated and evaluated through experiments. The first prototype combustor used a dummy heater. The second combustor has been designed to fit a V160 stirling engine. For both combustors, carbon monoxide, unburned hydrocarbons and oxides of nitrogen have been measured. During these measurements combustor parameters such as thermal power, relative air/fuel ratio/exhaust gas recirculation/fuel flow and inlet temperatures have been varied in order to obtain a complete emission map. Two computer models have been used to predict emissions and temperatures. The first model predicts heat losses, temperature in the combustor and NO_x emissions with a simple model. The other model used is Chemkin, which includes a one-dimensional laminar flame and full chemistry. The temperature profile from the first model is used as input to Chemkin. There is good agreement between measured emissions and emissions predicted with Chemkin. For the final version of the V160 combustor with an oxidizing catalyst, total emissions are less than 0.5 g/kWh ($HC+NO_x+CO$) which is in the same range as an otto engine with a good three-way catalytic converter, or even better. 21 refs, 39 figs

3303 Electric-Powered Systems

Refer also to citation(s) 6761, 6764, 6829

6915 (ANL/ET/CP–81277) **Three-dimensional finite element modeling of a magnet array spinning above a conductor.** Lorimer, W.L. (Univ. of California, Berkeley, CA (United States). Dept. of Mechanical Engineering); Lieu, D.K.; Hull, J.R.; Mulcahy, T.M.; Rossing, T.D. Argonne National Lab., IL (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931013–3: Conference on computation of electromagnetic fields, Miami, FL (United States), 31 Oct - 4 nov 1993). Order Number DE94004573. Source: OSTI; NTIS; GPO Dep.

Drag forces due to eddy currents induced by the relative motion of a conductor and a magnetic field occur in many practical devices: motors, brakes, magnetic bearings, and magnetically levitated vehicles. Recently, finite element codes have included solvers for 3-D eddy current geometries and have the potential to be very useful in the design and analysis of these devices. In this paper, numerical results from three-dimensional modeling of a magnet array spinning above a conductor are compared to experimental results in order to assess the capabilities of these codes.

3306 Vehicle Design Factors

Refer also to citation(s) 7034

3307 Emission Control

6916 (DOE/ER/81187–94/C0255) **Particulate control for coal-fueled diesel engine exhaust.** Smolensky, L.A.; Easom, B.H. LSR Technologies, Inc., Acton, MA (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER81187. (CONF-930893–25: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94002787. Source: OSTI; NTIS; GPO Dep.

The Core Separator is a cylindrical vessel having one tangential inlet and two outlets at the opposite end of the vessel. It contains an outlet for the clean flow and a second outlet for the recirculating flow. The solids-laden flue gas is introduced through a fan to the inlet of the Core Separator. Due to the swirling motion of the flow, solids move to the periphery as the central jet leaving the system through the central outlet is cleaned of particulates. The peripheral flow with most of the particles is exhausted to the cyclone and then recirculates back to the Core Separator by means of the fan. The processes of separation and solids collection are accomplished separately and in different components. The Core Separator cleans the flow discharged from the system and detains solids within the system If the Core Separator efficiency is high enough, particles cannot leave the system. They recirculate again and again until the cyclone finally collects them for removal. An analytical formula can be derived that defines the system performance. $E = E_c E_s / 1-E_s(1-E_c)$, where E, E_c, and E_s are the system, collector, and Core Separator partial separation efficiencies respectively. Examination of this equation shows that the system efficiency remains high even with poor performance in the collector, as long as the efficiency of the Core Separator is high. For example, if E_s is 99% and E_c is 30%, the system efficiency is 96.7%.

3308 Alternative Fuels

Refer also to citation(s) 6066, 6377, 6378, 6379, 6380, 6381, 6382, 6383, 6384, 6385, 6386, 6387, 6396, 6423, 6437, 6459, 6771, 6822, 6907

6917 (DOE/EE–0007) **Alternative fuel vehicles for the state fleets: Results of the 5-year planning process.** Abacus Technology Corp., Chevy Chase, MD (United States). May 1993. 121p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004709. Source: OSTI; NTIS; GPO Dep.

This report documents the first attempt by the Department of Energy (DOE) to work with states to prepare five-year Alternative Fuel Vehicle (AFV) acquisition plans to identify alternative fuels and

vehicles that they are planning on or would like to acquire. The DOE Regional Support Offices (RSOs) met with representatives from the states in their regions and assisted in the preparation of the plans. These plans will be used in conjunction with previously gathered Federal five-year plans to encourage Original Equipment Manufacturers (OEMs) to expand the variety of AFVs produced, reduce the incremental cost of AFVs, and to encourage fuel suppliers to expand the alternative fuel infrastructure and alternative fuel availability. By identifying the needs and requirements of state fleets, DOE can begin to describe the specific nature of the future state fleets, and establish a defined market for OEMs and fuel suppliers. DOE initiated the development and collection of the state five-year plans before the signing of the Energy Policy Act, to raise the awareness of states that they will be required by law to acquire AFVs. As a result, several states that had no AFV acquisition plan when queried have developed or are in the process of developing plans. The DOE and its RSOs are still working with the states to develop and refine acquisition plans, and this report should be treated as documentation of work in progress.

6918 (DOE/MC/25124–94/C0245) **Commercialization of coal diesel engines for non-utility and export power markets.** Wilson, R.P.; Balles, E.N.; Rao, K.; Benedek, K.R.; Benson, C.E.; Mayville, R.A.; Itse, D.; Kimberley, J.; Parkinson, J. Little (Arthur D.), Inc., Cambridge, MA (United States). [1993]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-88MC25124. (CONF-930893–22: Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat, Morgantown, WV (United States), 3-5 Aug 1993). Order Number DE94002971. Source: OSTI; NTIS; GPO Dep.

The basic motivation behind this project is to develop coal-burning heat engine technology primarily for 10-100 MW modular stationary power applications in the late 1990's and beyond, when oil and gas prices may return to the $5–7/MMBtu range. The fuel is a low-cost, coal-based liquid with the consistency of black paint, composed of 12-micron mean size premium 2% ash coal dust mixed 50/50 with water. The Clean Coal Diesel Plant of the future is targeted for the 10-100 MW non-utility generation (NUG) and small utility markets, including independent power producers (IPP) and cogeneration. A family of plant designs will be offered using the Cooper-Bessemer 3.8, 5.0, and 6.3 MW Model LS engines as building blocks. In addition, larger plants will be configured with an engine in the 10-25 MW class (Cooper will license the technology to other large bore stationary engine manufacturers). The reciprocating engine offers a remarkable degree of flexibility in selecting plant capacity. This flexibility exists because the engines are modular in every sense (fuel cell stacks have similar modularity). Scale-up is accomplished simply by adding cylinders (e.g., 20 vs 16) or by adding engines (4 vs 3). There is no scale-up of the basic cylinder size. Thus, there is essentially no technical development needed to scale-up the Cooper-Bessemer Clean Coal Diesel Technology all the way from 2 MW (one 6-cylinder engine) to 50 MW (eight 20-cylinder engines), other than engineering adaptation of the turbocharger to match the engine.

6919 (NEDO-P–9207) **Present situation of petroleum substitution energy development (Germany).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 46p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE94732336. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Recently a share of petroleum in the total energy supply has been in an upward trend in Germany. Crude oil imports in 1992 were 98.9 million tons. The largest crude oil exporter to Germany is CIS, followed by UK, Norway and Libya. Since the Chernobyl nuclear power plant accident, confidence in the nuclear power generation has been lowering in Germany. Discussion, therefore, has been arisen that nuclear power should be given up and strenuous efforts should be exerted to develop petroleum substitution energy mostly like renewable energy. The German government, however, shows a negative attitude toward supporting introduction of renewable energy to the market, basically considering that renewable energy has not been quantitatively sufficient to play a role in energy supply, nor its economical efficiency has been improved so much that the introduction of renewable energy can be promoted with subsidies of approximately 50%. Technological development for petroleum substitution energy is conducted by the Research and Technology Ministry such as a large-scale demonstrative project and transfer of technology results. 2 figs., 7 tabs.

6920 (NEDO-P–9228) **Survey on effects of petroleum substitution energy utilization on the global environment.: Current policies of the major countries coping with the global warming problem and the energy demand and supply.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 199p. (In Japanese). Sponsored by New Energy and Industrial Technology Development Organization, Tokyo (Japan). Order Number DE94732339. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Investigations/analyses are conducted on objectives, policies and measures of the world's major countries in relation to the Framework Convention on Climate Change, particularly CO2 emission. The problem on climate change is a global issue, and the CO2 emission control is directly connected with energy consumption closely related to national economies. Therefore, interests conflict between the north and the south, and among the developed countries. The U.S. Clinton administration is beginning to show a more positive attitude than before, and aims to take the most realistic measures such as the proposed new Btu tax in the developed countries. As for EC, whether or not CO2 stabilization targeted in 2000 is made possible depends on how much Germany can achieve the target. British strong opposition attitude toward the carbon/energy taxes presents a question to the target to be attained by 2000. Hereafter, tie-ups jointly taken for CO2 control measures between developed countries and developing countries are expected to be a matter of increasing importance. 43 figs., 43 tabs.

6921 (NREL/CP–200-5768-Vol.2, pp. 1116-1132) **Expanding liquid transportation fuels through methanol, higher alcohols & ethers.** Piel, W.J. (Argo Chemical Co., Newton Square, PA (United States)). National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

The highest value for fuel alcohols is in the use of making replacement transportation fuels. The economics of converting biomass to replacement fuels alcohols via the pyrolysis/synthesis gas route is nearly competitive today. However, the economics is more than competitive if the marketplace has full access to the currently available government subsidy for renewable based fuels. Replacement fuels from biomass have the potential to replace up to 15% of the US gasoline derived from petroleum, and replace even more if the oxygen limits in gasoline can be eventually raised. The use of biomass based replacement fuels would also significantly reduce the US emissions of carbon dioxide and other greenhouse gases.

35 ARMS CONTROL

Refer also to citation(s) 7373

3501 Policy, Negotiations, and Legislation

Refer also to citation(s) 6305

6922 (IAEA-INFCIRC–173(add.1)) **Text of the agreement between the Czechoslovak Socialist Republic and the Agency for the application of safeguards in connection with the treaty on the non-proliferation of nuclear weapons: Succession by the Czech Republic.** International Atomic Energy Agency, Vienna (Austria). Jul 1993. 6p. (In Arabic, Chinese, English, Spanish,

French, Order Number DE94611053. Source: OSTI; NTIS (US Sales Only); INIS.

The document informs that the Czech Republic succeeded to the Treaty on the Non-Proliferation of Nuclear Weapons on 1 January 1993 and to the agreement between the Czechoslovak Socialist Republic and the Agency for the application of safeguards in connection with the above treaty.

6923 (IAEA-INFCIRC–173(add.2)) **Text of the agreement between the Czechoslovak Socialist Republic and the Agency for the application of safeguards in connection with the treaty on the non-proliferation of nuclear weapons: Succession by the Slovak Republic.** International Atomic Energy Agency, Vienna (Austria). Jul 1993. 6p. (In Arabic, Chinese, English, Spanish, French, Order Number DE94611054. Source: OSTI; NTIS (US Sales Only); INIS.

The document informs that the Slovak Republic succeeded to the Treaty on the Non-Proliferation of Nuclear Weapons on 1 January 1993 and to the agreement between the Czechoslovak Socialist Republic and the Agency for the application of safeguards in connection with the above treaty.

3502 Proliferation

Refer also to citation(s) 6306, 6307, 7377

6924 (SAND–93-2663C) **The status of United States R&D programs in safeguards and physical protection.** Mangan, D.L. (Sandia National Labs., Albuquerque, NM (United States)); Tape, J.W. Sandia National Labs., Albuquerque, NM (United States). [1993]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9311121–1: 14. annual meeting of Institute of Nuclear Materials Management, Tokyo (Japan), 9-10 Nov 1993). Order Number DE94002685. Source: OSTI; NTIS; INIS; GPO Dep.

Short communication. FISSILE MATERIALS/safeguards; NUCLEAR WEAPONS/radioactive waste processing; PLUTONIUM/safeguards; SAFEGUARDS; NUCLEAR MATERIALS MANAGEMENT; PROLIFERATION; PLUTONIUM; PHYSICAL PROTECTION; ARMS CONTROL

3503 Verification

6925 (LA-UR–93-4108) **Munitions classification using an Acoustic Resonance Spectroscopic technique.** Roberts, R.S.; Chen, J.T.; Vela, O.A.; Lewis, P.S. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9311135–3: Institute of Electrical and Electronic Engineers (IEEE) asilomar conference on signals, systems, and computers, Pacific Grove, CA (United States), 1-3 Nov 1993). Order Number DE94003939. Source: OSTI; NTIS; GPO Dep.

In support of the Bilateral Chemical Weapons Agreement between the United States and Russia, Los Alamos National Laboratory has developed a nondestructive evaluation (NDE) technique that discriminates between different types of artillery munitions. This NDE classification technique allows on-site inspectors to rapidly classify the munitions as chemical or high explosive, and furthermore discriminates between various subclasses of these types of munitions. This technique, based on acoustic resonance measurements, has been successfully demonstrated on a wide variety of high explosive and chemical munitions. The technique consists of building templates of spectral features from sets of known munitions. Spectral features of unknown munitions are compared with a library of templates, and the degree of match between the features and the templates is used to classify the munition. This paper describes the technique, including the feature extraction, clustering and classification algorithms.

6926 (PNL-SA–22406) **High sensitivity, low profile neutron detector for safeguards measurements.** Miley, H.S.; Abraham, J.R.; Thompson, R.C.; Sunberg, D.S. Pacific Northwest Lab., Richland, WA (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931051–1: Nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 31 Oct - 6 nov 1993). Order Number DE94003703. Source: OSTI; NTIS; GPO Dep.

A neutron detector has been constructed and tested at Pacific Northwest Laboratory (PNL) for the purpose of making fast, high sensitivity measurements of neutron emitters in portal applications. The system is based upon glass fiber optic scintillators loaded with lithium-6 and operated to detect thermal neutrons. Due to their compact size. physical flexibility, freedom from microphonic pickup, and complete lack of environmental and safety concerns, these fibers are very suitable for some applications. The electronics needed for these fibers is somewhat more complex than for helium-3 proportional counters, but the entire electronics package (including the controlling computer) has been shrunk into a space of 20 x 25 x 2 cm. The prototype sensor is about 180 x 60 x 7 cm, but a final design now under construction measures 200 x 28 x 2.54 cm. The new, smaller detectors will be capable of ganging to achieve any needed sensitivity and will each weigh about 16 kg. The principles of operation of the fiber will be discussed as will the operational mode of the detector.

6927 (PNL-SA–22408) **Intrinsic signatures of polymer based fiber reinforced composite structures: An ultrasonic approach.** Good, M.S.; Hansen, N.H.; Heasler, P.G.; Undem, H.A.; Fuller, J.L.; Skorpik, J.R. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 11p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9309303–1: 20. quantitative nondestructive evalution (QNDE) meeting, Brunswick, ME (United States), 1-6 Sep 1993). Order Number DE94004270. Source: OSTI; NTIS; GPO Dep.

Combination of ultrasound, image comparison, and statistical analysis provide a method for acquiring a subsurface, intrinsic signature from polymer based, fiber-reinforced composites. Although materials properties are carefully controlled, localized fluctuations in the macrostructure and microstructure permit a basis for ultrasound and other NDE methods to read intrinsic signatures from a material. Under ideal conditions where a material signature is stable and has sufficient spatial features as a signature, an error rate on the order of one-out-of-a-million is feasible. A conclusion of an independent functional test performed on the laboratory prototype as it existed in June 1991 is that the system proved effective as a proof-of-concept system. An issue raised by the independent evaluation is that system performance is still at risk of factors relating to signature stability, particularly moisture absorption and material creep. System improvements made to mitigate noise sources identified by the independent evaluation include (1) implementation of a 3.0 – 4.5 μS software gate, (2) use of a RMS amplitude instead of the gated peak amplitude, and (3) optional use of a suction cup holder to facilitate reader alignment and scan consistency.

36 MATERIALS

Refer also to citation(s) 7105

6928 (ORNL/FTR–4748) **Travel to Japan to participate in the 3rd International Union Materials Research Society (IUMRS) International Conference on Advanced Materials: Foreign trip report, August 29–September 4, 1993.** Tiegs, T.N. Oak Ridge National Lab., TN (United States). 14 Sep 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94000505. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The traveler visited Japan and attended the 3rd IUMRS International Conference on Advanced Materials held in Tokyo. Topics of interest at the conference included presentations on cost-effective ceramics, processing of silicon nitride, and environmentally conscious materials.

3601 Metals and Alloys

Refer also to citation(s) 6040, 6199, 6214, 6227, 6228, 6527, 6697, 6834, 7013, 7014, 7016, 7026, 7045, 7064, 7120, 7122,

7141, 7142, 7182, 7298, 7543, 7755, 7851, 7879, 7889, 7890, 7891, 7892

6929 (ANL/MSD/CP–79851) **Mechanical properties of nanophase materials.** Siegel, R.W. (Argonne National Lab., IL (United States)); Fougere, G.E. Argonne National Lab., IL (United States). Nov 1993. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38 ; FG02-86ER45229. (CONF-9306223–3: North Atlantic Treaty Organization (NATO) advanced study meeting of Institute on Nanophas Materials, Corfu (Greece), 20 Jun - 2 jul 1993). Order Number DE94004625. Source: OSTI; NTIS; GPO Dep.

It has become possible in recent years to synthesize new materials under controlled conditions with constituent structures on a nanometer size scale (below 100 nm). These novel nanophase materials have grain-size dependent mechanical properties significantly different than those of their coarser-grained counterparts. For example, nanophase metals are much stronger and apparently less ductile than conventional metals, while nanophase ceramics are more ductile and more easily formed than conventional ceramics. The observed mechanical property changes are related to grain size limitations and/or the large percentage of atoms in grain boundary environments; they can also be affected by such features as flaw populations, strains and impurity levels that can result from differing synthesis and processing methods. An overview of what is presently known about the mechanical properties of nanophase materials, including both metals and ceramics, is presented. Some possible atomic mechanisms responsible for the observed behavior in these materials are considered in light of their unique structures.

6930 (ANL/MSD/CP–80132) **Reduction of defect fluxes using dual-ion-beam processing.** Iwase, A.; Rehn, L.; Baldo, P.M.; Okamoto, P.R.; Wiedersich, H.; Funk, L. Argonne National Lab., IL (United States). Nov 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931108–21: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004605. Source: OSTI; NTIS; GPO Dep.

Radiation-induced segregation (RIS) in Ni-12.7% Si and Cu-l% Au alloys was studied using Rutherford backscattering spectroscopy during He and Ne irradiation at elevated temperatures. During single ion-beam irradiation with 1.5 MeV He, strong RIS of Si toward the surface was observed in Ni 12.7% Si. Simultaneous irradiation with 400 keV Ne and 1.5 MeV He almost completely suppressed the Si segregation, even when the calculated damage production rate by Ne was only a few percent of that by He ions. A similar effect of dual-beam irradiation was observed in the Cu-l% Au alloy, i.e., the rate of near surface Au depletion was strongly reduced under simultaneous irradiation. Result shows that dual-beam irradiation can be applied to control RIS and RED (Radiation Enhanced Diffusion) during ion beam processing.

6931 (ANL/MSD/CP–80133) **Suppression of thermal gain growth in nickel by prior electron irradiation.** Gao, Yuzun, Allen, C.W.; Birtcher, R.C. Argonne National Lab., IL (United States). Nov 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931108–14: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004602. Source: OSTI; NTIS; GPO Dep.

An anomalous effect of electron irradiation on thermal grain growth in Ni has been observed using in situ TEM. Grain growth during thermal annealing was suppressed in areas irradiated with electrons. Grain growth suppression required a minimum electron energy between 100 and 200 keV. This alteration of thermal grain growth is attributed to electron beam injection of a surface contaminant such as carbon. This work points out that care must be exercised in the execution and evaluation of in situ TEM or ion beam experiments that deal with microstructural changes which are highly compositionally sensitive.

6932 (ANL/MSD/CP–80134) **Modulation wavelength dependence of ion mixing in metallic superlattices.** Alexander, D.E.; Fullerton, E.E.; Baldo, P.M.; Sowers, C.H.; Rehn, L.E. Argonne National Lab., IL (United States). Nov 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931108–16: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004608. Source: OSTI; NTIS; GPO Dep.

Ion mixing was studied in polycrystalline Nb/V and single-crystal Mo/V superlattices and in bilayers of the same materials. Systematic variation in the modulation wavelength, Λ, revealed a factor of three decrease in mixing efficiency at small Λ for Nb/V. The decrease appears to coincide with a structural transition in which the Nb/V superlattices become coherent. The results are consistent with a diffusion-induced grain boundary migration interpretation of mixing during irradiation.

6933 (CONF-9210121–, pp. 149-150) **Materials science experiments in the ISOSPIN laboratory.** Sawicki, J.A. (Chalk River Laboratories, Chalk River, Ontario (Canada)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

This paper touches on the application of radioactive ion beams to problems in materials science and condensed matter physics. The author addresses the problem from his background in Moessbauer spectroscopy, where radioactive ion beams are used in the study of materials and processes related to the nuclear industry. Examples include studying the properties of Zr based alloys, corrosion phenomena in reactor cooling loops, and properties of catalysts for environmentally safe chemical processing. The author stresses the range of materials applications a radioactive beam facility can have, but also the need to integrate low operating costs, fast response to research proposals, and flexible scheduling, to serve this group of users.

6934 (CONF-9305134–, pp. 1-8) **Cryotribological applications in superconducting magnets.** Michael, P.C. (Massachusetts Institute of Technology, Cambridge, MA (United States)); Iwasa, Y.; Rabinowicz, E. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The authors have previously advocated the development of materials selection guidelines for high-performance superconducting magnets on the basis of steady-state sliding stability. Theoretical and experimental evidence suggests that inherently stable friction materials may be physically impossible at cryogenic temperatures. The authors propose an alternate strategy for improving low-temperature sliding stability within the framework of available material behaviors.

6935 (CONF-9305134–, pp. 9-15) **One-component surface waves in anisotropic linear elastic media.** Barnett, D.M. (Stanford Univ., CA (United States)). Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The author considers the possibility that a single partial wave (an inhomogeneous plane wave) can serve as a free surface (Rayleigh) wave in an anisotropic linear elastic half-space. The conditions required for the existence of such a wave are derived from a study of the fundamental eigenvalue problem set by A.N. Stroh for steady plane disturbances in anisotropic solids. The author shows by direct computation that such one-component waves are necessarily supersonic; since isotropic solids do not admit supersonic surface wave solutions, these one-component waves are pure anisotropic effects. A stable solid of triclinic symmetry yielding one-component surface waves is constructed and discussed. In the limit as the supersonic surface wave speed approaches that of a

subsequent transonic state, the one-component surface wave becomes an exceptional homogeneous plane wave.

6936 (CONF-9305134–, pp. 40-47) **Fundamental aspects of brittle damage processes – discrete systems.** Krajcinovic, D. (Arizona State Univ., Tempe, AZ (United States)); Lubarda, V. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The analysis of cooperative brittle processes are performed on simple discrete models admitting closed form solutions. A connection between the damage and fracture mechanics is derived and utilized to illustrate the relation between two theories. The performed analyses suggest that the stress concentrations (direct interaction between defects) represent a second order effect during the hardening part of the response in the case of disordered solids.

6937 (CONF-9305134–, pp. 48-55) **Fluidization and segregation in bi-disperse solid-liquid particulate systems.** Kytoemaa, H.K. (Massachusetts Institute of Technology, Cambridge, MA (United States)); Peterson, C.R.; McClintock, F.A.; Schiaffino, S. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Fluidization is investigated as an energy efficient method of removing fines in a machine in which comminution and material transport are integrated features of the design. Two different conditions are explored. In the first, small mono-disperse particles are steadily fluidized within a randomly arranged fixed bed of bigger particles. The results show that the fluidization conditions can be predicted by means of an extension of the general correlations proposed by Richardson and Zaki, and intended for fluidization of mono-disperse particles in confined beds. In the second, a uniformly mixed binary bed of glass spheres is impulsively fluidized. The transient bed behavior is found to be more complex than what can be projected from the present understanding of the steady state. The initial upward motion of the packed bed forms an upward moving void which is essential for segregation to occur. These experimental findings can be directly used to integrate an efficient separation process into new crushing machines. Information on the optimization of the machine working conditions can be extracted from the obtained results.

6938 (CONF-9305134–, pp. 70-76) **Effective elastic properties of cracked solids.** Kachanov, M. (Tufts Univ., Medford, MA (United States)). Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The classical problem of effective elastic properties of cracked solids is critically reviewed. The predictions of the existing schemes are directly checked by computer experiments on a large number of sample arrays of interacting cracks. The main finding is that the approximation of non-interacting cracks (the simplest one) actually remains accurate at high crack densities and strong interactions. The underlying reason is that the competing interaction effects of shielding and amplification cancel each other (provided the mutual positions of cracks are random).

6939 (CONF-9305134–, pp. 85-92) **The Preisach model with stochastic input as a model for aftereffect.** Mayergoyz, I.D. (Univ. of Maryland, College Park, MD (United States)); Korman, C.E. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

In previous papers it has been suggested to use the Preisach model driven by stochastic inputs as a model for aftereffect. However, in these papers the stochastic inputs have been modeled by discrete time i.i.d. (independently identically distributed) random processes. Here, the aforementioned approach is further extended by modeling the stochastic inputs by continuous time diffusion processes. It is shown that the mathematical machinery of the "exit problem" is instrumental for calculations of time evolutions of the expected value of the output of the Preisach model.

6940 (CONF-9305134–, pp. 93-102) **Small strain heterogeneous deformation in polycrystals.** Shi, S. (Univ. of Connecticut, Storrs, CT (United States)); Jordan, E.H.; Walker, K.P. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

A program to study the micromechanics of polycrystalline deformation is outlined. The viscoplastic stress-strain behavior of a polycrystalline metal was successfully predicted from the measured single crystal properties of the same metal and the predictions were experimentally verified. Current research focuses on predicting the grain to grain heterogeneity of the mechanical response. This response has been predicted using both a self-consistent method and a more detailed method using an integral equation approach. The predicted response will be compared with a Moire strain analysis and neutron diffraction experiments to be performed on a coarse grained sample of polycrystalline Hastelloy-X metal. The goal is to produce an experimentally verified model capable of realistically modeling the heterogeneous mechanical response due to orientation variation of the grains in the polycrystal.

6941 (CONF-9305134–, pp. 111-115) **Fracture toughness as a function of constraint for simulated weldments.** Reuter, W.G. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Lloyd, W.R.; Epstein, J.S. Argonne National Lab., IL (United States). 1993. DOE Contract AC07-76ID01570. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

One of the primary needs in structural design is the ability to predict structural integrity using fracture toughness data obtained from small, standard test specimens. Sufficient understanding of the fracture process in homogeneous, isotropic materials has been gained to extend the research into weldments, which are considered to be the primary region of fracture for structural components. Weldments have a great many parameters that influence fracture, and it is very difficult to isolate their effects on the fracture process. Specimens of a "model system" were fabricated to reduce this complexity. This paper provides preliminary results of fracture toughness testing of these simulated weldments.

6942 (CONF-9305134–, pp. 213-220) **Application of hysteresis modeling to magnetic techniques for monitoring biaxial stress.** Sablik, M.J. (Southwest Research Institute, San Antonio, TX (United States)); Burkhardt, G.L.; Kwun, H. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

A probe, consisting of two excitation coils and a detection coil wrapped around a core with a Hall probe between the pole pieces, has been used to measure indirectly the influence of biaxial stress on the magnetic properties of a ferromagnetic specimen, in this case annealed SAE-4130 steel. Properties measured indirectly included remanence, coercivity, and first, third and fifth harmonic amplitudes. The properties were extracted from the voltage measured across the detection coil and incorporate the magnetic influence of the soft iron core, but with the effect of air gap variation between pole piece and sample kept to a controlled range.

Results were compared to micromagnetic model for the effect of biaxial stress on hysteresis and on magnetic properties. The micromagnetic model is a modified version of a model previously employed by Schneider et al. The experimental remanence variation due to biaxial stress compared very well to the predictions of the model. Furthermore, the model predicts, and experiment bears out, that the remanence with the field along one stress axis minus the remanence with the field along the other stress axis falls in a straight-line band of values when plotted against the difference of the two stresses. This suggests a possible NDE technique for detecting differences in biaxial stresses at a given location in a steel specimen.

6943 (CONF-9305134–, pp. 221-228) **Mixing and settling in continuous metal production.** Richter, H.J. (Dartmouth College, Hanover, NH (United States)); Laaspere, J.T.; Fitzpatrick, J.M. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Modern metallurgical processes produce metal from ore in a single converter operated in horizontal mode to permit staging of bath and oxygen potential by utilizing bottom-blowing of oxygen and fuel. The submerged injectors must create sufficient turbulence to provide excellent gas-liquid contact in order to maximize heat and mass transfer in the bath, but this turbulence must be selectively localized so as to provide adequate phase separation zones of metal and slag between the active turbulent zones. It is important to know the behavior of gas and liquids in the bubble plume, the nature and paths of liquids and entrainment into the plume, and separation phenomena including travel and behavior in the settling zones. Such knowledge is of fundamental value in designing reactors for continuous direct metal making. In this work the mixing caused by submerged injection of gas into a bath simulating a converter and subsequent phase separation of two immiscible liquids representing slag and metal respectively, are being studied experimentally and analytically. First results of experiments and of the numerical analysis are presented.

6944 (CONF-9305134–, pp. 279-286) **Intelligent sensing and control of gas metal arc welding.** Smartt, H.B. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Johnson, J.A. Argonne National Lab., IL (United States). 1993. DOE Contract AC07-76ID01570. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Intelligent sensing and control is a multidisciplinary approach that attempts to build adequate sensing capability, knowledge of process physics, control capability, and welding engineering into the welding system such that the welding machine is aware of the state of the weld and knows how to make a good weld. The sensing and control technology should reduce the burden on the welder and welding engineer while providing the great adaptability needed to accommodate the variability found in the production world. This approach, accomplished with application of AI techniques, breaks the tradition of separate development of procedure and control technology.

6945 (CONF-9305134–, pp. 287-294) **Welding process decoupling for improved control.** Hardt, D.E. (Massachusetts Inst. of Technology, Cambridge, MA (United States)); Eagar, T.W.; Lang, J.H.; Jones, L. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The Gas Metal Arc Welding Process is characterized by many important process outputs, all of which should be controlled to ensure consistent high performance joints. However, application of multivariable control methods is confounded by the strong physical coupling of typical outputs of bead shape and thermal properties. This coupling arises from the three dimensional thermal diffusion processes inherent in welding, and cannot be overcome without significant process modification. This paper presents data on the extent of coupling of the process, and proposes process changes to overcome such strong output coupling. Work in rapid torch vibration to change the heat input distribution is detailed, and methods for changing the heat balance between base and fill material heat are described.

6946 (CONF-9305316–, pp. 1-4) **Formation of TiC/TiAl in situ composite layer on diecast aluminium alloy by electrical discharge alloying.** Tsunekawa, Y. (Toyota Technological Institute, Aichi (Japan)); Okumiya, M.; Mori, N.; Kosugi, T. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

This paper describes a new method of surface modification of diecast aluminum alloy (ADC12) by electrical discharge alloying. This process proceeds to deposition and alloying with titanium powder in electrode and with carbon decomposed from hydrocarbon working fluid on the surface of aluminum alloys. The electrical discharge alloying with the electrode of Ti/36mass%Al premixed green compact synthesizes an in situ composite layer consisted of TiC and TiAl on ADC12 surfaces. This process makes it possible not only to form in situ composite layers with an average thickness of 100μm, but also to vary the TiC volume ratio in the layer by the process parameters. The morphology of TiC shows extremely fine dendritic precipitates due to rapid solidification during the process. The volume ratio of TiC decreases with increasing distance from the surface, which means the layer has a gradient constituent. The hardness close to the surface can be selected to a given value depending upon the TiC ratio. 8 refs., 8 figs.

6947 (CONF-9305316–, pp. 5-8) **Development of multi coated steel by thermal spraying-hot rolling method. 2.** Mizoguchi, S. (Nippon Steel Corp., Tokyo (Japan)); Sugino, K.; Yano, S. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

This paper describes qualities of the Cu(outer layer)/Ni(inner layer) double coated steel obtained by the sealed wire arc spraying-hot rolling method. Sectional micro-texture and weldability of the multi coated steel were investigated. Oxides in the coated layer were identified by the X-ray diffraction method. It was illustrated that the cuprous oxide is included in the coated layer obtained by the non-sealed wire are spraying in air. Consequently, it was found that the Cu and Ni coating obtained by wire arc spraying in air, which seals the flame with nitrogen gas, is very clean compared with the non-sealed one. It was also revealed that after hot rolling, the Cu/Ni double coated steel exhibits good weldability because it has clean coated layers. It was considered that blowholes are formed by the reaction between the cuprous oxide in Cu coated layer and the hydrogen in the ambient atmosphere. 1 ref., 6 figs., 1 tab.

6948 (CONF-9305316–, pp. 9-12) **Influence of the temperature rise of Fe-C base alloy deposits during thermal spraying on their structures and mechanical properties.** Murakami, K. (Osaka University, Osaka (Japan). The Institute of Scientific and Industrial Research); Okamoto, T.; Kawai, T.; Miyamoto, Y.; Matsumoto, H. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

In this investigation, powders of Fe-2.19wt.%C-0.68wt.%Si alloys and Fe-1.50wt.%C-10.7wt.%Cr alloys were low pressure plasma

sprayed onto substrates which were cooled to various extents. It was found that the deposit held at low temperatures during spraying consisted predominantly of retained austenite supersaturated with carbon. The strength of the deposit, which was measured on the tensile test pieces machined from the deposit, was low. When the deposit temperature was allowed to rise during spraying by the heat from the plasma flame, carbide precipitates were dispersed in the ferrite matrix. With increasing maximum temperature of the deposit, the adhesion between the lamellae composing the deposit became stronger, the porosity decreased, and the carbide precipitates became coarser. Furthermore, it was revealed that owing to the combined effects of all these structural changes, the strength reached a maximum when the deposit temperature was adequately raised during spraying. 5 refs., 5 figs.

6949 (CONF-9305316–, pp. 13-15) **Properties of SUS440C/Ag composite coatings deposited by wire explosion spraying.** Matsubara, T. (Kyushu University, Fukuoka (Japan). Research Institute for Applied Mechanics); Fukuda, S. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

In order to develop high wear resistance materials in the space environment, SUS440C (martensitic stainless steel) coating and laminated composite coatings of SUS440C/Ag were prepared by means of the wire explosion spraying. Were investigated the main properties of both coatings, as for microstructure, chemical composition, porosity, Vickers microhardness, and adhesive strength. Consequently, it was found that the distribution of chromium is homogeneous and the porosity is about 2%. It was also found that the carbon content in the coating is about half of the carbon content in the wires. The Vickers microhardnesses of SUS440C and SUS440C/Ag were Hv406 and Hv290, respectively. Furthermore, the adhesive strength was about 41MPa on the brass substrate and about 56MPa on the SUS304 substrate. Accordingly, it was demonstrated that the adhesive strength depends on the kind of substrative materials. 3 refs., 2 figs., 3 tabs.

6950 (CONF-9305316–, pp. 21-29) **Energy problems and thermal spraying.** Iwamoto, N. (Osaka University, Osaka (Japan). Welding Research Institute). 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

Plasma spraying is an important technology for the surface modification. The needs are widely spreading for coating system in the field of energy production, such as fusion reactor, MHD (magnetohydrodynamics) power generation, coal liquefaction and gasification, geothermal power generation, developments of space and ocean, biomedical use, fuel cell, super conductor film, etc. In this paper, a comparison of various spraying methods, such as air thermal spraying, electromagnetic concentration multi-arc plasma spraying, low pressure plasma spraying, and radio-frequency plasma flash deposition, is made from the viewpoint of getting good quality of coating. Wear resistance, thermal shielding, and anticorrosion of various plasma spraying methods are illustrated. Also, are introduced applications of the plasma spraying to engines and gas turbines, super conductive oxide films, and solid oxide fuel cell. Especially, this paper discusses the perfectly molten ZrO2 by the use of hybrid and multi-arc coating processes. 25 refs., 8 figs., 5 tabs.

6951 (CONF-9305316–, pp. 30-33) **Valuation of spray coatings with the scanning vibrating electrode.** Tsukiyama, S. (Osaka Industrial University, Osaka (Japan). Faculty of Engineering); Magome, M.; Ogawa, S. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

The current density of the Ni/Cr based deposit by plasma spraying was measured using a scanning vibrating electrode apparatus. Powders of 80Ni/20Cr and 50Ni/50Cr were DC plasma sprayed to prepare the deposits. The anti-corrosion of spray deposit was determined by the scanning vibrating electrode using a 3%NaCl solution. Platinum and Ag/AgCl were used as the electrode and the inert electrode, respectively. The distance between the spray deposit and the tip of microelectrode was fixed to 100μm. The amplitude and frequency of the vibrator were 100μm and 100Hz, respectively. Consequently, it was confirmed that the distribution of current density on the surface of the spray deposit is clearly determined with the scanning vibrating electrode apparatus. It was also suggested that the distribution of current density has a relation with the distribution of crevice corrosion. Accordingly, it was demonstrated that the anti-corrosion of the plasma spray deposit can be evaluated by the scanning vibrating electrode technique. 11 refs., 5 figs.

6952 (CONF-9305316–, pp. 46-49) **Thermal shock testing for sprayed coating.** Matsuda, J. (Government Industrial Research Institute, Shikoku, Kagawa (Japan)); Utsumi, A.; Yoneda, M.; Katsumura, M.; Kagawa, S.; Miyoshi, Y.; Araki, T. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

Compositionally gradient coatings against thermal shock have been developed by a laser spraying method. These coatings consist of titanium and titanium nitride. The chemical components were graded through the coatings with the thickness of about 1mm. In order to examine characteristics of these coatings, a new testing apparatus for repeated thermal shock has been made on an experimental basis. The heat source of this new testing apparatus is a high speed axial flow multi-mode type carbon dioxide laser beam, and its maximum output is 5kW. Titanium nitride layers, which were coated on mild steel plates by means of a laser spraying method, were used as the tested materials. As a consequence of testing, the surface temperature reached 2,000K for 4 seconds in the case of 290W/cm^2 under the condition of 4kW of power supply and 42mm of beam diameter. In addition, it was possible to repeat thermal shocks at the rate of 3 times a minute between room temperature and 2,000K at the surface or 1,000K at the bottom of the coating in the depth of 1mm. 4 refs., 6 figs.

6953 (CONF-9305316–, pp. 50-53) **Thermal shock characteristics of thermally sprayed ZrO2 coatings with over-coated Al.** Ishida, T. (Nagasaki Institute of Applied Science, Nagasaki (Japan)); Tani, N.; Hiraki, K. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Available from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

The repetition of thermal shock for ZrO2 coatings, which are thermally sprayed on steel surface, gives an occasion of their crack or exfoliation. While, the initiation of crack or exfoliation of ZrO2 coatings can be delayed by the overlay coating of aluminum, in the course of the repetition of thermal shock. Aluminum overlay coating also brings about the sealing effect to the pores remained in the ZrO2 coatings, and makes a contribution to raising the degree of cohesion between particles. In order to verify this phenomenon, thermal shock tests were carried out using thermally sprayed ZrO2 coating pieces and those with over-coated aluminum. The effect of aluminum overlay coating on the crack or exfoliation of ZrO2 coatings, and the effect of heat treatment after thermal spraying were investigated. Consequently, it was revealed that for the thermally sprayed ZrO2 coating with over-coated aluminum, the initiation of crack or exfoliation is delayed, and the crack or exfoliation expands in the smaller region. 1 ref., 8 figs., 1 tab.

6954 (CONF-9305316–, pp. 79-84) **Thermally sprayed coatings for high temperature environments.** Harada, Y. (Tocalo Co. Ltd., Kobe (Japan)). 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

In gas turbines, the acceleration of high temperature corrosive attack on blades, vanes, and combustor is well known, which is caused by the presence of ash deposits containing vanadium, sodium, and sulfur compounds. Therefore, thermally sprayed coatings are widely used in practice as an effective means for the high temperature parts in gas turbines and jet engines. This paper describes corrosion and damage under the high temperature atmosphere, as for the corrosivity of high temperature combustion gas and the interaction between high temperature corrosion and metal components. It also introduces outlines of high temperature coatings by thermal spraying process, MCrAlX (M=Fe,Ni,Co; X=Y,Hf,Sc,Ce,La, etc.) alloy coatings, and thermal barrier coatings. Especially, characteristics of various components composing the MCrAlX alloy are illustrated. Furthermore, advantages of low pressure plasma sprayed coatings using the MCrAlX alloy are presented. 18 refs., 5 figs., 2 tabs.

6955 (CONF-9305316–, pp. 85-88) **Multi-layer coating processing by thermal spraying using wet plating.** Hara, T. (Kagawa Industrial Technology Center, Kagawa (Japan)); Tomino, H.; Yamashita, M.; Moriya, K.; Kandaka, Y.; Uemura, Y.; Katsumura, M.; Yoneda, M. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

Formation of multi-layered coatings in which corrosion resistance and wear resistance are secured by a plated layer and a thermal spray coating layer respectively was carried out by interposing a plated layer between the substrate and the thermal spray coating layer. Al alloy for substrate and Ni-Cr-Al composite powder for spraying material were used. The plated layer is composed from a Ni-P plated layer produced by electroless deposition and a Cr layer produced by electroplating. Good joining interface can be obtained only by coarsening and activating the base layer prior to both spraying and plating. Accordingly, three methods were investigated where the surface of the substrate is blasted and then plated to be spray-coated; the surface of substrate is plated and then blasted to be spray-coated; and the surface of the substrate is blasted, plated, blasted again and spray-coated. The plated coating can be formed also on the blast-treated surface. Any of the above methods can provide the surface of a plated layer sufficient for forming a spray-coating. The Ni-P plated coating has an effect to strengthen adhesivity to Ni-based spray material. 6 refs., 6 figs.

6956 (CONF-9305316–, pp. 89-92) **Study of the adhesion between paint film and metal spraying layer.** Kawahara, S. (Nakayama Steel Works, Ltd., Osaka (Japan)); Sumida, R. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

Adaptability of combined application of coating to the surface sprayed with corrosion-resistant metal was examined from the viewpoint of placing importance on appearance. Test samples were prepared by applying various kinds of coating to SS 400 steel thermally sprayed with Zn, Al, and treated with a Zn-rich paint. In applying coating, two kinds of sealers, epoxy-based and silicate-based, were used. Testing was carried out by changing also overcoating paint. As accelerated tests, brine spraying and warm-water dipping tests were conducted; atmospheric exposure tests were applied in factory districts and seaside districts to evaluate the adhesivity between the underground layer and coating film. Differences in adhesivity were found depending on the kind of sealer. Whereas good adhesivity is obtained by using silicate-based sealers for Zn-sprayed films, epoxy-based ones give good results for Al-sprayed films. Use of unadaptable coating systems causes bad results in the Zn-rich paint. The atmospheric test has been continued for 1.5 years and no particular abnormality is found in all specimens. 2 figs., 5 tabs.

6957 (CONF-9305316–, pp. 93-96) **Anti-corrosion of plasma sprayed coatings.** Koso, R. (Osaka Industrial Univ., Osaka (Japan)); Magome, M.; Ogawa, S. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

Corrosion resistance of plasma sprayed alloy films was examined and compared by SVET(Scanning Vibrating Electrode Method). In addition, the nature of sprayed films was examined by using an electron beam microanalyzer and X-ray diffraction. Powder of 80Ni-20Cr and 50Ni-50Cr alloy is used to form films by DC and RF plasma spray coating devices. SVET was done by scanning the surface of spray coating with a minute electrode and measuring the local potential or corrosion current density. The RF spray coating produced more uniformly distributed Ni and Cr elements and a smaller amount of oxygen compared with the DC spray coating. This is because the RF method produces uniform particles due to slow particle velocity and accordingly long retention time, and at the same time, the diffusion and intrusion of external oxygen is slow due to the shielding effect of gas flame. RF spray coating is superior to DC spray coating in corrosion resistance though it exhibits non-uniformity of corrosion current density and the advancement of local corrosion. In addition, 50Ni-50Cr coating exhibits a corrosion current density smaller than 80Ni-20Cr coating. 3 refs., 3 figs.

6958 (CONF-9305316–, pp. 97-99) **Anti-corrosion of Ni-Cr plasma spray coatings.** Dozono, T. (Osaka Industrial University, Osaka (Japan)); Magome, M.; Hidaka, K.; Tanaka, K. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

An investigation was made on the difference in corrosion resistance due to the form of powdery material between 80Ni-20Cr and 50Ni-50Cr plasma alloy spray coatings. The sizes of powder are 145-250, 250, 250-500 meshes and water-atomized size. SUS 304 and Hastelloy C plates were used for comparison. Anode polarization was used for the evaluation of corrosion resistance. With the increase of current density accompanying the increase of potential, corrosive coatings are formed to generate a stationary passivity maintaining current density(i passive). The i passive of these spray coatings became greater than those of plate material of SUS 304 and Hastelloy C. The anode polarization characteristic shows changes depending on particle form, and 50Ni-50Cr exhibits lower passivity current density smaller than 80Ni-20Cr. The passivity potential becomes nobler and the passivity current density curve shows a gentle peak in spray coatings. Water-atomized 50Ni-50Cr spray coating exhibited a corrosion-resistant tendency. 1 ref., 3 figs., 1 tab.

6959 (CONF-9305316–, pp. 104-106) **Characteristics of TOP GUN system.** Imai, E. (Mitsui Bussan Machine Tool Co. Ltd., Tokyo (Japan)). 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

The thermal spray technology is shifting from the conventional D-GUN process to the high velocity oxygen fuel (HVOF) method. This paper introduces the newly developed HVOF top gun system.

A top gun, cooled by water, heats and accelerates a material using a gas mixing unit and a combustion chamber/expansion nozzle combination. Oxygen and fuel gas are mixed just before combustion. Use of various kinds of fuel gases provides such a high temperature combustion gas jet that cannot be obtained by other HVOF methods, thereby making it possible to spray high-melting point materials. The system also features such structural characteristics as an easy-to-operate program control, a safety-designed control console, and many others. The result of observing the sprayed films verified that a hardness from 1200 to 1300 was obtained with WC12 Co at Hv 300, and dense and smooth film with Al2O3-TiO3. A molybdenum spraying produced a film with as high hardness as 1000 at Hv 300. 5 figs.

6960 (CONF-931118–1) **Experimental and analytical comparison of constraint effects due to biaxial loading and shallow-flaws.** Theiss, T.J.; Bass, B.R.; Bryson, J.W. Oak Ridge National Lab., TN (United States). [1993]. 56p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC05-84OR21400. From 2. symposium on constraint effects in fracture; Fort Worth, TX (United States); 17-18 Nov 1993. Order Number DE94004794. Source: OSTI; NTIS; INIS; GPO Dep.

A program to develop and evaluate fracture methodologies for the assessment of crack-tip constraint effects on fracture toughness of reactor pressure vessel (RPV) steels has been initiated in the Heavy-Section Steel Technology (HSST) Program. The focus of studies described herein is on the evaluation of a micromechanical scaling model based on critical stressed volumes for quantifying crack-tip constraint through applications to experimental data. Data were utilized from single-edge notch bend (SENB) specimens and HSST-developed cruciform beam specimens that were tested in HSST shallow-crack and biaxial testing programs. Shallow-crack effects and far-field tensile out-of-plane biaxial loading have been identified as constraint issues that influence both fracture toughness and the extent of the toughness scatter band. Results from applications indicate that the micromechanical scaling model can be used successfully to interpret experimental data from the shallow- and deep-crack SENB specimen tests. When applied to the uniaxially and biaxially loaded cruciform specimens, the two methodologies showed some promising features, but also raised several questions concerning the interpretation of constraint conditions in the specimen based on near-tip stress fields. Crack-tip constraint analyses of the shallow-crack cruciform specimen based on near-tip stress fields. Crack-tip constraint analyses of the shallow-crack cruciform specimen subjected to uniaxial or biaxial loading conditions are shown to represent a significant challenge for these methodologies. Unresolved issued identified from these analyses require resolution as part of a validation process for biaxial loading applications.

6961 (CONF-931239–1) **Current status of research and development on nickel and iron aluminides.** Liu, C.T.; George, E.P.; McKamey, C.G. Oak Ridge National Lab., TN (United States). [1993]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 3. international SAMPE symposium on intermetallics; Chiba (Japan); 7-10 Dec 1993. Order Number DE94004247. Source: OSTI; NTIS; GPO Dep.

This paper provides a comprehensive review of current status of research and development on nickel and iron aluminides based on Ni_3Al, NiAl, Fe_3Al and FeAl. These aluminides possess attractive properties for elevated-temperature structural use; however, brittle fracture and poor fracture resistance have limited their use as engineering materials in many cases. in recent years, considerable effort has been devoted to the study of the brittle fracture behavior of these aluminides; as a result, both intrinsic and extrinsic factors governing brittle fracture have been identified. Surprisingly, moisture-induced hydrogen embrittlement has been recognized as one of the major causes of low ductility and brittle fracture in Ni_3Al, Fe_3Al and FeAl at ambient temperatures. These efforts have led to the development of ductile and strong aluminide alloys for structural applications. Industrial interest in these aluminide alloys is high, and several examples of industrial involvement are mentioned.

6962 (DOE/ER/45184–9) **The role of grain boundary chemistry and structure in the environmentally-assisted intergranular cracking of nickel-base alloys: Progress report, [December 1, 1990–November 31, 1993].** Was, G.S. Michigan Univ., Ann Arbor, MI (United States). Dept. of Nuclear Engineering. [1993]. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-85ER45184. Order Number DE94003159. Source: OSTI; NTIS; GPO Dep.

Progress focused on (1) determination of the role of C and Cr on deformation and IG cracking behavior of Ni-(5–30)Cr-9Fe, (2) determination of the effect of grain boundary misorientation on IG cracking behavior, (3) construction of an electron backscattering pattern (EBSP) imaging system, (4) determination of effect of the environment on creep and cracking, and (5) characterization of the surface film. Results showed that both C and Cr are potent solid solution strengtheners which can reduce the steady state creep rate at 360°C by several orders of magnitude. Intergranular cracking of 100 μm grain samples of high purity Ni-16Cr-9Fe at 360°C occurs by formation of grain boundary voids and interlinkage, driven by dislocation creep in the matrix. Creep experiments in primary water at 360°C and an applied cathodic potential show that the creep rate is increased by an order of magnitude over that in Ar and the percent IG fracture increases as well. Oxide film composition and thickness is a sensitive function of the C content, increasing in thickness and $Ni(OH)_2$ content with increase in C or decrease in Cr to 5 wt%. Thermomechanical treatments along with electron channeling pattern (ECP) analysis wee used to create and index, samples with enhanced fractions of coincident site lattice boundaries (CSLBs). Constant extension rate tensile (CERT) experiments on samples with a high percentage of CSLBs showed IG cracking compared with general high angle boundaries. However, these experiments were conducted on grain sizes of 300 μm, while commercial material is an order of magnitude smaller. An electron backscattering pattern imaging system has been constructed for an environmental scanning electron microscope which can image grains below μm. The system has been successfully benchmarked against results from ECP analysis.

6963 (DOE/FTR–93018254) **Travel to Germany for the International Symposium on Metal/Ceramic Interfaces: Foreign trip report, June 28–July 6, 1991.** Loehman, R.E. Sandia National Labs., Albuquerque, NM (United States). 11 Dec 1991. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93018254. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Metal-ceramic interfaces are of considerable practical and theoretical interest. Such interfaces determine function of devices and structures such as multilayer microelectronic packaging, bonding of advanced heat engine components, and fabrication of high vacuum feedthroughs and power tubes. Discontinuities at interfaces present a difficult challenge to the theorist. This symposium was the latest in a biannual series that alternates its venue between the US and Europe. It was organized to follow a modified Gordon Conference format, which allowed for extensive discussions among the seventy five participants. Highlights of this symposium were results of theoretical modelling of interfaces using the image force technique, the detailed description of the Max-Planck diffusion bonding instrument, Ohuchi's XPS studies showing how the degree of bond covalency in the ceramic affects bonding, and the detailed HREM studies of the structures of model interfaces.

6964 (DTH-LV-MEDD–227) **GEOmesh: An automatic grid generator for 3D Cartesian grids.** Thomsen, J.M. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Varmeisolering. Sep 1991. 35p. (In Danish). Order Number DE94730212. Source: OSTI; NTIS.

In this report the work of developing and improving of the 1990 version of automatic grid generator GEOmesh for general Cartesian grids is described. It is a part of a programming package for the purposes of form casting and hardening simulation. The 'old' version and necessary input data are given.Improvements are focused on the quality of the generated grid, in particular on 'smoothness' ('smooth' grid is here is a grid, where volumes of the elements generated do not differ essentially from element to element). The necessary input parameters are reviewed and a simple geometry's effect on the generated grid is shown.Some examples of generated grids for various geometries are listed.The new version is proved to generate a better grid, often by means of fewer elements. (EG)

6965 (INIS-mf–13740) **A higher order shear deformation theory for laminated anisotropic plates and its application in defence industry.** Pervez, T. Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). 1992. 16p. (CONF-9204276–: Seminar on research and development in support of technology with military applications, Karachi (Pakistan), 29 Apr 1992). Order Number DE94610232. Source: OSTI; NTIS (US Sales Only); INIS.

Composite materials have been used for centuries, brick reinforced with straw, laminated iron-steel swords, gun-barrels and concrete, to name but a few. Today industrial innovations improved energy planning, uncertain availability have created a greater interest in search of new materials. Now that increasingly performance requirements are forcing many conventional materials to the limit, the engineer's approach of fitting the design to the properties is changing into one of finding materials with the right properties to meet the demand of design, service of economics. The use of composite materials have progressed through several stages in past two and half decade. First, demonstration pieces were built with the idea of let's see if we can build one. For second stage, replacement pieces, part of the objective was to test a part designed to replace a metal part in an existing application. The last stage is actual production pieces designed from the beginning to be fabricated wholly from composite. This last goal is being approached in deliberate, conservation and multistage fashion. A substantial composite technology has been developed and awaits further challenge. In this paper new higher order shear deformable theory for anisotropic laminated composite is presented. The finite element method is used to get static and dynamic solution for the plate with and without damping effects. Finally, example and discussion are presented to demonstrate the accuracy of the theory presented herein. (author).

6966 (IS-T–1653) **Directional solidification studies in Ni-Al alloys.** Lee, Je-hyun. Ames Lab., IA (United States). May 1993. 214p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005562. Source: OSTI; NTIS; INIS; GPO Dep.

Three solid phases are involved in the phase equilibria of the intermetallic compound Ni_3Al near its melting point, β, $\gamma'(Ni_3Al)$, and γ. The generally-accepted phase diagram involves a eutectic reaction between β' and γ, but some recent studies agree with an older diagram due to Schramm, which has a eutectic reaction between the β and γ' phases. The phase equilibria near Ni_3Al compositions was evaluated using quenched directional solidification experiments, that preserve the microstructures tonned at the solidification front, and using diffusion couple experiments. These experiments show that eutectic forms between β and γ' phases, as in the Schramm diagram. Growth and phase transformations of these three phases are also studied in the directional solidification experiments. Microstructure analysis shows that etching of $Ni_3Al(\gamma')$ is very sensitive to small composition variations and crystallographic orientation changes. The eutectic solidification study confirms that the equilibrium eutectic is $\gamma'+\beta$, and that the metastable $\gamma+\beta$ eutectic might be also produced in this system according to the impurities, solidification rates, and composition variations.

6967 (IS-T–1660) **Geometric structures of thin film: Pt on Pd(110) and NiO on Ni(100).** Warren, O.L. Ames Lab., IA (United States). Jul 1993. 153p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-7405-ENG-82. Grant CHE-9014214; Grant CHE-9024358. Order Number DE94005564. Source: OSTI; NTIS; INIS; GPO Dep.

This thesis is divided into 3 papers: dynamical low-energy electron- diffraction investigation of lateral displacements in topmost layer of Pd(110); determination of (1×1) and (1×2) structures of Pt thin films on Pd(110) by dynamical low-energy electron-diffraction analysis; and structural determination of a NiO(111) film on Ni(100) by dynamical low-energy electron-diffraction analysis.

6968 (IS-T–1688) **Terfenol: A study of the phase equilibrium diagram and the solidification process.** Anderson, M. Ames Lab., IA (United States). 7 Dec 1993. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94004883. Source: OSTI; NTIS; GPO Dep.

Terfenol is a rare earth-iron alloy that was first developed at the Naval Ordinance Laboratory because of its rare magnetostrictive properties. Terfenol is composed of terbium and dysprosium combined with iron in a composition $Tb_xDy_{1-x}Fe_2$, where x~0.3. The objective of this work was to determine the growth characteristics of Terfenol and its dependence on solidification rate, temperature gradient, and stoichiometry. Specific goals of this work were to verify the phase equilibria that is currently accepted for the systems $DyFe_2$ and $TbFe_2$, and establish the phase equilibria near the composition $Tb_{0.3}Dy_{0.7}Fe_2$; establish that Terfenol grows directly from the liquid and that the reaction is occurring under metastable conditions; evaluate whether or not Terfenol can be grown under plane front conditions with a new radiofrequency float zone apparatus, and; determine whether or not <111> seeded crystals can be grown and <111> single crystals produced by elimination of dendrites employing growth methods capable of achieving high gradient/solidification rate ratios.

6969 (KAERI/AR–352/92) **Reconstitution of charpy impact specimens for life extension of power reactor.** Kim, Sung Soo (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Han, Dae June; Kang, Young Hwan. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). May 1992. 54p. (in Korean). Order Number DE94610233. Source: OSTI; NTIS (US Sales Only); INIS.

The report describes the state-of-the-arts for the reconstitution of Charpy impact specimens in order to increase the reliability of fracture toughness results of the irradiated specimen in the view of life extension program of power reactor to be carried out in the future. The reconstituted Charpy specimen can increase the number of specimens by three times since each half of Charpy specimen can be recovered to a full impact specimen by proper welding process. The reliability of test results with irradiated specimen can be enhanced by the reconstituted Charpy impact specimens, so these specimens can be used to get another data in the life extension research program to investigate the variation of fracture toughness of irradiated materials as a function of neutron fluence. These specimens can also be used to get additional test results for thermal annealing study when in-situ annealing of the reactor vessel is needed. This report reviews the method to make two full Charpy specimen (reconstituted Charpy) specimen from two halves of tested specimen and the applicability of this method to life extension program, and compares the characteristics of various welding methods. (Author).

6970 (KFK–5177) **MANET-II - Investigation results on the transformation and tempering behaviour and examination on the mechanical properties.** Schirra, M.; Graf, P.; Heger, S.; Meinzer, H.; Schweiger, W.; Zimmermann, H. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Materialforschung; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion. May 1993. 87p. (In German). Order Number DE94734065. Source: OSTI; NTIS (US Sales Only); INIS.

This report presents the results of a number of investigations undertaken to characterise the MANET-II-Material (MArtensit for Next European Torus). It was delivered in the form of rods and plates, fabricated from 6 different heats. The transformation behaviour is described in the form of a time-temperature-transformation diagram (TTT) and the tempering behaviour by hardening (T = 850-1150 C) and tempering tests (T = 200-800 C). The dependence of the tensile strength upon tempering temperature (T = 200-800 C) and on the test-temperature (T = room temperature-750 C) was investigated. The creep and creep-rupture behaviour was determined for the temperature range between 450 and 700 C up to a maximum test-time of 10000 hours. The impact strength for different tempering conditions is presented in the form of A_v-t-curves (T = -150-+200 C). (orig.)

6971 (LA–12637-T) **Metastable phases in the aluminum-germanium alloy system: Synthesis by mechanical alloying and pressure induced transformations.** Yvon, P. Los Alamos National Lab., NM (United States). Jan 1994. 219p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005402. Source: OSTI; NTIS; GPO Dep.

Thesis Submitted to California Institute of Technology, Pasadena, CA.

Al and Ge form a simple equilibrium eutectic with limited mutual solubility and no intermetallic intermediate phases. We used a regular solution approach to model effects of pressure on Al-Ge. Effects of pressure are to extend solubility of Ge in Al, to displace the eutectic composition towards the Ge rich side, and to slightly decrease the eutectic temperature. We designed thermobaric treatments to induce crystal-to-glass transformations in fine grain mixtures of Al and Ge. We used Merrill-Bassett diamond anvil cells to perform experiments at high pressures. We built an x-ray apparatus to determine the structure of alloys at pressure and from cryogenic temperatures to 400C. Two-phase Al-Ge samples with fine microstructures were prepared by splat-quenching and mechanical alloying. We observed a crystal-to-glass transformation at about 80 kbar. The amorphous phase formed was metastable at ambient temperature after pressure release. This was confirmed by TEM. The amorphous phase obtained by pressurization was found to have a liquid-like structure and was metallic. In the TEM samples we also observed the presence of a second amorphous phase formed upon release of the pressure. This second phase had a tetrahedrally-bonded continuous random network structure, similar to that of semi-conducting amorphous germanium.

6972 (LA–12685-MS) **New equation of state for stainless steel 347.** Boettger, J.C. Los Alamos National Lab., NM (United States). Dec 1993. 9p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94004189. Source: OSTI; NTIS; GPO Dep.

A new SESAME equation of state (EOS) for stainless steel 347 has been generated using the computer program GRIZZLY, and has been added to the SESAME EOS library as material number 4271. This new EOS is superior to its predecesser (material number 4270) in several respects.

6973 (LA-UR–93-3966) **Corrosion resistant coatings from conducting polymers.** Wrobleski, D.A. (Los Alamos National Lab., NM (United States)); Benicewicz, B.C.; Thompson, K.G.; Bryan, C.J. Los Alamos National Lab., NM (United States). [1993]. 3p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940301–3: 207. spring national meeting of the American Chemical Society, San Diego, CA (United States), 13-18 Mar 1994). Order Number DE94003959. Source: OSTI; NTIS; GPO Dep.

Cr-based corrosion resistant undercoatings will have to be replaced because of environmental and health concerns. A coating system of a conducting polyaniline primer layer topcoated with epoxy or polyurethane, is being evaluated for corrosion resistance on mild steel in 0.1 M HCl or in a marine setting. Results of both laboratory and Beach Site testing indicate that this coating is very effective; even when the coatings are scratched to expose bare metal, the coated samples show very little signs of corrosion in the exposed area. 3 figs, 6 refs.

6974 (LA-UR–93-3981) **Case studies of corrosion of mixed waste and transuranic waste drums.** Kosiewicz, S.T. Los Alamos National Lab., NM (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931108–9: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94003957. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents three case studies of corrosion of waste drums at the Los Alamos National Laboratory (LANL). Corrosion was not anticipated by the waste generators, but occurred because of subtle chemical or physical mechanisms. In one case, drums of a cemented transuranic (TRU) sludge experienced general and pitting corrosion. In the second instance, a chemical from a commercial paint stripper migrated from its primary containment drums to chemically attack overpack drums made of mild carbon steel. In the third case, drums of mixed low level waste (MLLW) soil corroded drum packaging even though the waste appeared to be dry when it was placed in the drums. These case studies are jointly discussed as "lessons learned" to enhance awareness of subtle mechanisms that can contribute to the corrosion of radioactive waste drums during interim storage.

6975 (LA-UR–93-4521) **Failures to model the development of a cube texture during the high temperature compression of Al-Mg alloys.** Kocks, U.F.; Chen, Shuh Rong; Dawson, P.R. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9309231–6: International conference on textures of materials, Clausthal (Germany), 20-24 Sep 1993). Order Number DE94005013. Source: OSTI; NTIS; GPO Dep.

A strong (100) fiber texture has been observed under some circumstances after the compression and tension of Al-Mg alloys. It is not due to static recrystallization after the text, but probably connected with some form of dynamic recrystallization. Possibilities that this unusual texture might rise from some unconventional deformation mechanisms were searched for but not found.

6976 (LBL–34017) **Cryogenic fracture behavior of 316LN in magnetic fields up to 14.6 T.** Chan, J.W. (Lawrence Berkeley Lab., CA (United States)); Chu, D.; Tseng, C.; Morris, J.W. Jr. Lawrence Berkeley Lab., CA (United States). Jul 1993. 8p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-930703–40: International cryogenic engineering conference and international cryogenic materials conference, Albuquerque, NM (United States), 12-16 Jul 1993). Order Number DE94005215. Source: OSTI; NTIS; GPO Dep.

Some of the proposed magnet case alloys for the International Thermonuclear Experimental Reactor (ITER) are metastable austenitic stainless steels. The case will be subjected to high loads and can be as much as 100 mm thick. Case assembly will probably require thick section welding with its attendant chemical inhomogeneity. Even alloys that are thermally stable with respect to martensitic transformation can, under these conditions of high stresses, cryogenic temperature, and high magnetic fields, undergo transformation. Previous work at 8 T has shown a measurable magnetic field effect on the 4.2K tensile and fracture toughness properties of AISI300 series metastable austenitic stainless steels. Thus, it is important to understand how these alloys will behave under conditions of high magnetic fields and cryogenic temperature, particularly at the higher magnetic fields that will be used in ITER. 4.2K data for 316LN indicates that the change in fracture toughness is not monotonic. It initially decreases and then later increases with applied field.

6977 (LBL–34018) **Growth of small fatigue cracks in Incoloy-908.** Mei, Z.; Krenn, C.; Morris, J.W. Jr. Lawrence Berkeley Lab., CA (United States). Jul 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-930703–39: International cryogenic engineering conference and international cryogenic materials conference, Albuquerque, NM (United States), 12-16 Jul 1993). Order Number DE94003406. Source: OSTI; NTIS; GPO Dep.

Incoloy-908 was designed as a structural alloy for the conduit of cable-in-conduit superconductors. The conduit is a thin-wall tube that encloses superconducting cables. Since the conduit may be as thin as 3 to 12 mm in thickness and is subject to cyclic loads, fatigue crack growth behavior at liquid helium temperature, especially in the small crack regime, is a critical issue for magnet design. Because it is difficult to perform small fatigue crack propagation tests at 4.2 K, we have studied mechanisms of small crack propagation at room temperature and 77 K, and use the results to propose a feasible method for estimating small crack propagation at 4.2 K.

6978 (LBL–34019) **Influence of grain structure and solute composition on the work hardening behavior of aluminium at cryogenic temperatures.** Chu, D.; Morris, J.W. Jr. Lawrence Berkeley Lab., CA (United States). Jul 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-930703–38: International cryogenic engineering conference and international cryogenic materials conference, Albuquerque, NM (United States), 12-16 Jul 1993). Order Number DE94003415. Source: OSTI; NTIS; GPO Dep.

An unrecrystallized structure is found to significantly improve the work hardening characteristics by lowering the work hardening rate during early stages of deformation. This is in contrast to a recrystallized structure, which requires a higher work hardening rate to accommodate the greater degree of multiple slip necessary to

maintain strain compatibility between the more randomly oriented grains. The stronger texture associated with the unrecrystallized structure allows deformation to occur more efficiently. Addition of magnesium also improves work hardening by increasing overall level of the work hardening rate. The improved characteristics of the work hardening behavior result in a parallel increase in both the strength and ductility at cryogenic temperatures. These findings are positive since they suggest a method by which improvements in the work hardening behavior and subsequent mechanical properties may be obtained through practical modifications of the microstructure and composition.

6979 (LBL–34793) **Research into the microstructure and mechanical behavior of eutectic Bi-Sn and In-Sn.** Goldstein, J.L.F. (Lawrence Berkeley Lab., CA (United States)); Mei, Z.; Morris, J.W. Jr. Lawrence Berkeley Lab., CA (United States). Aug 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9308103–1: 8. international electronic materials and processes congress, San Jose, CA (United States), 30 Aug - 2 sep 1993). Order Number DE94004558. Source: OSTI; NTIS; GPO Dep.

This manuscript reports on research into two low-melting, lead-free solder alloys, eutectic Bi-Sn and eutectic In-Sn. The microstructures were found to depend on both cooling rate and substrate, with the greatest variability in the In-Sn alloy. The nature of the intermetallic layer formed at the solder-substrate interface depends on both the solder and the substrate (Cu versus Ni). Also, the microstructure of the Bi-Sn can recrystallize during deformation, which is not the case with In-Sn. Data from creep and constant strain rate tests are given for slowly cooled samples. The creep behavior of In-Sn is constant with temperature, but the creep seems to be controlled by the In-rich phase in In-Sn on Cu and by the Sn-rich phase in In-Sn on Ni. Bi-Sn exhibits different creep behavior at temperatures above 40 °C than at 20 °C or lower. Stress-strain curves of Bi-Sn on Cu and In-Sn on Cu are similar, while In-Sn on Ni behaves differently. This is explained in terms of the deformation patterns in the alloys.

6980 (LBL–34795) **Cracking of textured zinc coating during forming process.** Mei, Z.; Morris, J.W. Jr. Lawrence Berkeley Lab., CA (United States). Sep 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-940235–1: International symposium on the physical metallurgy of zinc coated steels: processing, structure and properties, San Francisco, CA (United States), 28 Feb - 3 mar 1994). Order Number DE94003414. Source: OSTI; NTIS; GPO Dep.

A model is presented to relate cracking of a zinc coating on steel during forming process with its crystallographic texture. There are three deformation modes that can accommodate strains in a zinc coating caused by external loadings; basal slip, twinning, and cleavage cracking. Twinning of a zinc hexagonal crystal induces a contraction along its c-axis while cleavage relaxes tensile strain along its c-axis. Because of this, when basal slip in grains of a textured zinc coating is difficult under a given loading, either twinning or cleavage occurs, depending on whether the basal plane is parallel or normal to the loading axis and whether the loading is tensile or compressive. The loadings during formability or surface friction tests cause twinning in the basal-textured coating and cleavage cracking in the prism-textured coating. The prism-textured coating contains in extraordinarily high hardness since none of the three deformation modes may be operative under compression. These results derived from the model are confirmed with recent studies on electrogalvanized steels.

6981 (LBL–34908) **Computer simulation of martensitic transformations.** Xu, Ping. Brookhaven National Lab., Upton, NY (United States). Nov 1993. 198p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94005213. Source: OSTI; NTIS; GPO Dep.

The characteristics of martensitic transformations in solids are largely determined by the elastic strain that develops as martensite particles grow and interact. To study the development of microstructure, a finite-element computer simulation model was constructed to mimic the transformation process. The transformation is athermal and simulated at each incremental step by transforming the cell which maximizes the decrease in the free energy. To determine the free energy change, the elastic energy developed during martensite growth is calculated from the theory of linear elasticity for elastically homogeneous media, and updated as the transformation proceeds.

6982 (LBL–34909) **Microstructural development and mechanical behavior of eutectic bismuth-tin and eutectic indium-tin in response to high temperature deformation.** Goldstein, J.L.F. (Univ. of California, Berkeley, CA (United States). Dept. of Materials Science and Mineral Engineering). Lawrence Berkeley Lab., CA (United States). Nov 1993. 105p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94005202. Source: OSTI; NTIS; GPO Dep.

The mechanical behavior and microstructure of eutectic Bi-Sn and In-Sn solders were studied in parallel in order to better understand high temperature deformation of these alloys. Bi-Sn solder joints were made with Cu substrates, and In-Sn joints were made with either Cu or Ni substrates. The as-cast microstructure of Bi-Sn is complex regular, with the two eutectic phases interconnected in complicated patterns. The as-cast microstructure of In-Sn depends on the substrate. In-Sn on Cu has a non-uniform microstructure caused by diffusion of Cu into the solder during sample preparation, with regions of the Sn-rich γ phase imbedded in a matrix of the In-rich β phase. The microstructure of In-Sn on Ni is uniform and lamellar and the two phases are strongly coupled. The solders deform non-uniformly, with deformation concentrating in a band along the length of the sample for Bi-Sn and In-Sn on Cu, though the deformation is more diffuse in In-Sn than in Bi-Sn. Deformation of In-Sn on Ni spreads throughout the width of the joint. The different deformation patterns affect the shape of the stress-strain curves. Stress-strain curves for Bi-Sn and In-Sn on Cu exhibit sharp decays in the engineering stress after reaching a peak. Most of this stress decay is removed for In-Sn on Ni. The creep behavior of In-Sn also depends on the substrate, with the creep deformation controlled by the soft P phase of the eutectic for In-Sn on Cu and controlled by the harder γ phase for In-Sn on Ni. When In-Sn on Ni samples are aged, the microstructure coarsens and changes to an array of γ phase regions in a matrix of the β phase, and the creep behavior changes to resemble that of In-Sn on Cu. The creep behavior of Bi-Sn changes with temperature. Two independent mechanisms operate at lower temperatures, but there is still some question as to whether one or both of these, or a third mechanism, operates at higher temperatures.

6983 (NUTEK–87-4937) **Mechanical properties of forged 10.5% Cr steels tested within cost 501, round 2, WP3 - final report projects 3S1.** Faellman, S. (ABB Stal AB, Finspaang (Sweden)); Johansson, Lennart. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). Jan 1993. 14p. Order Number DE94730436. Source: OSTI; NTIS.

ABB Stal has contributed to the programme of COST 501, round 2, work package 3, by performing mechanical test on three trial melts (D1, D1.2 and E2) and on material taken from two full scale rotors (rotor E and rotor F). The aim has been to develop more heat resistant 12% Cr steels with a creep resistance of 100 MPa at 600 degrees C and 10^5h. This report describes the tensile, toughness and creep properties achieved in these steels in the as received conditions and after ageing treatments. The investigated steel show a considerable improvement in creep strength compared to conventional 12% Cr steels. The best results were obtained for steel E2 which is likely to meet the creep goal. Different ageing treatments and overageing does not influence these steels detrimentally. Long term creep properties are kept and only a minor increase in $FATT_{50}$ temperature is observed. 10 figs, 6 tabs

6984 (NUTEK–89-1157) **Quality in heat treatment - Analysis of the cooling process and testing of PC-based computer programs for hardening.** Segerberg, S. (IVF, Gothenburg (Sweden)); Bodin, J. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). Nov 1992. 17p. (In Swedish). Order Number DE94730437. Source: OSTI; NTIS.

In heat treatment the cooling process is the most critical phase for the quality of the products. Knowledge of cooling is a prerequisite to be able to tackle problems like form changes and crack risks, as well as to predict the results of the heat treatment through

computer calculations. Industrial cooling is commonly done without direct action on the cooling process. In this project a number of methods have been investigated, where it is possible to influence the cooling rate during the cooling process. The methods that gave the greatest influence were ultra sound, moving of the parts, and interrupted cooling, respectively. Three computer programs for PCs have been tested and compared with the results from hardening of test rods. The differences between the programs were great, and the most expensive program gave the best result.

6985 (ORNL/FTR–4673) **Travel to Europe to visit fracture technology research centers and a nuclear reactor fabrication facility: Foreign trip report, May 29–June 12, 1993.** Pennell, W.E.; Corwin, W.R. Oak Ridge National Lab., TN (United States). 14 Jul 1993. 37p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE93017909. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Visits were made to eight European fracture technology research centers and one nuclear reactor fabrication facility. Objectives were to understand fracture technology issues of concern to the European nuclear power community and research in progress aimed at their resolution. This information will be integrated into the planning process for the HSST and HSSI pressure vessel integrity research programs. Emphasis was placed on identification of areas of research where further interaction with one or more of the European research centers could enable the HSST and HSSI Programs to achieve specific research objectives earlier and/or at a reduced cost. Recommendations for possible further interaction on specific fracture technology research topics are provided for consideration by the NRC.

6986 (PNL–8926) **General Motors Corporation and Pacific Northwest Laboratory staff exchange: Inspection of case hardened steels and metal-matrix composites.** Good, M.S. (Pacific Northwest Lab., Richland, WA (United States)); Rogers, D.D. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003470. Source: OSTI; NTIS; GPO Dep.

Staff exchanges, such as the one described in this report, are intended to facilitate communication and collaboration among scientists and engineers at Department of Energy (DOE) laboratories, in US industry, and academia. Funding support for these exchanges is provided by the DOE, Office of Energy Research, Laboratory Technology Transfer Program. The exchanges offer the opportunity for the laboratories to transfer technology and expertise to industry, gain a perspective on industry's problems, and develop the basis for further cooperative efforts through Cooperative Research and Development Agreements (CRADAs) or other mechanisms. The objectives of this report were as follows: for Pacific Northwest Laboratory (PNL) staff to present technology to General Motors (GM) staff on nondestructive measurement of hardened steel components and uniformity of particle dispersion in metal-matrix composites for evaluation for possible application in GM's manufacturing processes; for GM staff to discuss with PNL staff common manufacturing processes, metallurgy, and flaw criteria for hardening of various components and manufacturing of metal-matrix composites; to provide an initial step in building a long-term collaborative relationship between PNL and GM. Information in this report on the staff exchange of PNL staff with GM Corporation includes the purpose and objectives, a summary of activities, significant accomplishments, significant problems, industry benefits realized, recommended follow-on work and potential benefits from that work, and three appendixes. Appendix A is a description of ultrasonic backscatter technology and its applications to the two nondestructive inspection interests defined by GM. Appendix B is a list of key contacts and the schedule of activities pertaining to the staff exchange. Appendix C is an article from American Society for Metals News relating to sensor needs.

6987 (PNL-SA–21725) **Radiation hardening effects on localized deformation and stress corrosion cracking of stainless steels.** Bruemmer, S.M. (Pacific Northwest Lab., Richland, WA (United States)); Cole, J.I.; Brimhall, J.L.; Carter, R.D.; Was, G.S. Pacific Northwest Lab., Richland, WA (United States). Aug 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830 ; FG02-93ER12130. (CONF-930825–14: 6. international symposium on environmental degradation of materials in nuclear power systems: water reactors, San Diego, CA (United States), 3-5 Aug 1993). Order Number DE94004308. Source: OSTI; NTIS; INIS; GPO Dep.

Radiation hardening in austenitic stainless steels modifies deformation characteristics and correlate well with increased susceptibility to intergranular stress corrosion cracking (IGSCC). Available data on neutron-irradiated materials have been analyzed and correlations developed between fluence, yield strength, and cracking susceptibility in high-temperature water environments. Large heat-to-heat differences in critical fluence (0.2 to 2.5 $\times$ 10^{21} n/cm^2) for IGSCC are documented. In many cases, this variability is consistent with yield strength differences among irradiated materials. IGSCC correlates better to yield strength than to fluence for most heats suggesting a possible role of radiation-induced hardening (and microstructure) on cracking. Microstructural evolution during proton and heavy-ion irradiation has been characterized in low-carbon 302SSs. Hardening results from dislocation loops. SEM and TEM are used to examine dose, strain, and temperature effects on deformation. This hardened microstructure produces inhomogeneous planar deformation within the matrix. Regularly spaced steps are created at the surface during deformation which increase in number with increasing macroscopic strain. Twinning is the dominant deformation mechanism at low temperature, while dislocation channeling is observed at 288C. Deformation characteristics are discussed in terms of potential impact on IGSCC.

6988 (PNL-SA–21736) **Potential high fluence response of pressure vessel internals constructed from austenitic stainless steels.** Garner, F.A. (Pacific Northwest Lab., Richland, WA (United States)); Greenwood, L.R.; Harrod, D.L. Pacific Northwest Lab., Richland, WA (United States). Aug 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930825–16: 6. international symposium on environmental degradation of materials in nuclear power systems: water reactors, San Diego, CA (United States), 3-5 Aug 1993). Order Number DE94004359. Source: OSTI; NTIS; INIS; GPO Dep.

Many of the in-core components in pressurized water reactors are constructed of austenitic stainless steels. The potential behavior of these components can be predicted using data on similar steels irradiated at much higher displacement rates in liquid-metal reactors or water-cooled mixed-spectrum reactors. Consideration of the differences between the pressurized water environment and that of the other reactors leads to the conclusion that significant amounts of void swelling, irradiation creep, and embrittlement will occur in some components, and that the level of damage per atomic displacement may be larger in the pressurized water environment.

6989 (PNL-SA–21753) **Early stages in the development of stress corrosion cracks.** Jones, R.H.; Simonen, E.P. Pacific Northwest Lab., Richland, WA (United States). [1993]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9305312–1: 4. international conference on fundamentals of fracture, Urabandai (Japan), 30 May - 4 jun 1993). Order Number DE94003867. Source: OSTI; NTIS; GPO Dep.

Processes in growth of short cracks and stage I of long stress corrosion cracks were identified and evaluated. There is evidence that electrochemical effects can cause short stress corrosion cracks to grow at rates faster or slower than long cracks. Short cracks can grow at faster rates than long cracks for a salt film dissolution growth mechanism or from reduced oxygen inhibition of hydrolytic acidification. An increasing crack growth rate with increasing crack length could result from a process of increasing crack tip concentration of a critical anion, such as Cl^-, with increasing crack length in a system where the crack velocity is dependent on the Cl^- or some other anion concentration. An increasing potential drop between crack tip and mouth would result in an increased anion concentration at the crack tip and hence an increasing crack velocity. Stage I behavior of long cracks is another early development stage in the life of a stress corrosion crack which is poorly understood. This stage can be described by $da/dt = AK^m$ where da/dt is crack velocity, A is a constant, K is stress intensity and m ranges

from 2 to 24 for a variety of materials and environments. Only the salt film dissolution model was found to quantitatively describe this stage; however, the model was only tested on one material and its general applicability is unknown.

6990 (PNL-SA–22435) **Neutron-induced microstructural alteration of GlidCop™ alloys at 415°C and high neutron exposure.** Edwards, D.J. (Pacific Northwest Lab., Richland, WA (United States)); Garner, F.A.; Newkirk, J.W.; Nadkarni, A. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930928–12: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94003808. Source: OSTI; NTIS; INIS; GPO Dep.

GlidCop™ internally oxidized copper alloys remain the leading candidates for high heat flux applications in fusion reactor. This paper presents the microstructural changes incurred in three GlidCop™ alloys exposed to long term, high temperature neutron irradiation. Irradiation at high temperature produced a microstructure containing a much lower dislocation density than the unirradiated specimens. Although 10–50 nm size triangular oxide particles were observed in areas with a very low number density of particles, spherical oxide particles on the order of 5–7 nm in diameter, thought to be $CuAl_2O_4$, were the predominant morphology. The changes in grain size distribution, dislocation density, and precipitate type and distribution saturate in the range of 34 to 50 dpa, as reflected in the saturation of mechanical properties.

6991 (PNL-SA–22442) **Irradiation creep and swelling of the U.S. fusion heats of HT9 and 9Cr-1Mo to 208 dpa at ~400°C.** Toloczko, M.B. (Univ. of California, Santa Barbara, CA (United States)); Garner, F.A.; Eiholzer, C.R. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930928–17: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94004367. Source: OSTI; NTIS; INIS; GPO Dep.

Ferritic-martensite steels are being considered for structural applications in fusion reactors. In order to provide data on the response of such steels to radiation, a series of experiments have been conducted in FFTF. Here, the irradiation creep and swelling behaviors of the fusion heats of HT9 and 9Cr-1Mo at ~400 C have been measured to exposures as large as 208 dpa, using both diametral and density measurements of helium-pressurized creep tubes. Void swelling was found in both alloys at 208 dpa to occur at rates of 0.012%/dpa or less, with the swelling of HT9 exhibiting a larger degree of stress enhancement than 9Cr-1Mo. The creep rate of HT9 is rather nonlinear in its response to hoop stress level in the range 0–200 MPa, but 9Cr-1Mo exhibits only slightly greater than linear behavior with stress level. The creep-swelling coupling coefficients for 9Cr-1Mo are consistent with values obtained for other steels.

6992 (PNL-SA–22444) **Influence of helium generation rate and temperature history on mechanical properties of model Fe-Cr-Ni alloys irradiated in FFTF at relatively low displacement rates.** Hamilton, M.L. (Pacific Northwest Lab., Richland, WA (United States)); Garner, F.A.; Edwards, D.J. Pacific Northwest Lab., Richland, WA (United States); Associated Western Universities, Inc., Salt Lake City, UT (United States); Washington State Univ., Richland, WA (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830 ; FG06-89ER75522. (CONF-930928–20: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94004264. Source: OSTI; NTIS; INIS; GPO Dep.

In agreement with earlier studies conducted at higher displacement rates, evolution of mechanical properties of model Fe-Cr-Ni alloys irradiated at lower displacement rates in the ^{59}Ni isotopic doping experiment does not appear to be strongly affected by large differences in helium generation rate. This insensitivity to helium/dpa ratio is exhibited during both isothermal and non-isothermal irradiation. The overall behavior of the model alloys used in this study is dominated by the tendency to converge to a saturation strength level that is independent of thermomechanical starting state and helium/dpa ratio, but which is dependent on irradiation temperature and alloy composition.

6993 (PNL-SA–22526) **Microstructural development in low activation ferritic alloys irradiated to 200 dpa at 420°C.** Gelles, D.S. Pacific Northwest Lab., Richland, WA (United States). [1993]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930928–21: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94004269. Source: OSTI; NTIS; INIS; GPO Dep.

Density change and microstructural development are reported for nine low activation ferritic steels covering the range 2.3 to 12 Cr with varying additions of V and/or W for hardening and up to 6.5 Mn for austenite stability. Specimens were examined following irradiation in FFTF/MOTA at 4200°C to a dose exceeding 200 dpa. Void swelling was found, but the swelling remained at 5% or below, with the worst case in an alloy of 9Cr-2Mn-1WV. The carbide structure pinning Martensite lath boundaries remains in place.

6994 (PNL-SA–22668) **Radiation effects in beryllium used for plasma protection.** Gelles, D.S. (Pacific Northwest Lab., Richland, WA (United States)); Dalle Donne, M.; Sernyaev, G.A.; Kawamura, H. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930928–18: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94004599. Source: OSTI; NTIS; INIS; GPO Dep.

Beryllium is presently a leading candidate material for fusion reactor first wall coating and divertor applications. This paper reviews the literature on beryllium, emphasizing the effects of irradiation on essential properties. Swelling and embrittlement experiments as a function of irradiation temperature and dose, and as a function of neutron spectrum are described, and the results are quantified, where possible. Effects of impurity content are also reported, from which optimum composition specifications can be defined. Microstructural information has also been obtained to elucidate the processes controlling the property changes. The available information indicates that beryllium divertors can be expected to embrittle quickly and may need frequent replacement.

6995 (PNL-SA–22941) **Grain boundary chromium concentration effects on the IGSCC and IASCC of austenitic stainless steels.** Bruemmer, S.M.; Arey, B.W.; Charlot, L.A. Pacific Northwest Lab., Richland, WA (United States). Aug 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930825–15: 6. international symposium on environmental degradation of materials in nuclear power systems: water reactors, San Diego, CA (United States), 3-5 Aug 1993). Order Number DE94004268. Source: OSTI; NTIS; INIS; GPO Dep.

Comparisons are made between grain boundary composition and intergranular stress corrosion cracking (IGSCC) of 304 and 309 austenitic stainless steels in high-temperature water environments. Chromium depletion had the dominant effect on cracking resistance with the extent of IG cracking controlled by the interfacial chromium concentration. The minimum chromium concentration required to promote cracking was a function of the applied strain rate during slow-strain-rate tensile tests in 288 C air-saturated water. Depletion from bulk levels of 18 wt% to ~13.5 wt% Cr at grain boundaries prompted 100% IG cracking at a strain rate of 1×10^{-6} s^{-1}, while embrittlement was observed with only a slight depletion to ~17 wt% at 2×10^{-7} s^{-1}. Insights into critical interfacial compositions promoting IGSCC are discussed in reference to cracking of irradiated stainless steel nuclear reactor core components.

6996 (PNL-SA–23016) **Effect of precipitate structure on hot deformation of Al-Mg-Mn alloys.** Vetrano, J.S.; Lavender, C.A.; Smith, M.T.; Bruemmer, S.M. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9310224–2: Materials Week '93, Pittsburgh, PA (United States), 17-21 Oct 1993). Order Number DE94004596. Source: OSTI; NTIS; GPO Dep.

The size and nature of precipitates have strong effects on microstructural evolution from the cold-worked state through the course of deformation at high temperatures. Through selected heat treatments and minor alloying alterations the precipitate structure of

AA5083 has been manipulated. Minor additions of Zr have been used to create fine (50 to 100 nm) precipitates. The number and size distribution of medium-sized (<1 μm) Mn-rich precipitates were modified by increasing the Mn concentration in conjunction with several heat treatment paths. Effects of these precipitates on the dislocation structure, recrystallization behavior and grain growth during high-temperature deformation have been elucidated.

6997 (SAND–93-1099C) **An anodic dissolution-based mechanism for the rapid cracking, "pre-exposure" phenomenon demonstrated by Al-Li-Cu alloys.** Buchheit, R.G. (Sandia National Labs., Albuquerque, NM (United States)); Wall, F.D.; Stoner, G.E.; Moran, J.P. Sandia National Labs., Albuquerque, NM (United States). [1993]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940222–9: Corrosion 94: National Association of Corrosion Engineers (NACE) international annual conference, Baltimore, MD (United States), 28 Feb - 4 mar 1994). Order Number DE94004798. Source: OSTI; NTIS; GPO Dep.

Al-Li-Cu alloys have been observed to fail in less than 24 hours after removal from a one week immersion in aerated 3.5 w/o NaCl solution. Anodic dissolution-based mechanisms proposed previously for this phenomenon have been amended based on further experiment and characterization of the rapid cracking process. Amendments are based on studies of the relative electrochemical behavior of the microstructural elements in the subgrain boundary region, time to failure SCC testing in a simulated crack solution, evolution of crack potential and pH with time, fractographic examination of failed samples, and X-ray diffraction of films passivating crack walls. Results suggest that an active path exists along subgrain boundaries that is comprised of the highly reactive T_1 (Al_2CuLi) precipitate phase and a solute depleted zone that does not readily passivate when exposed to the crack environment. The matrix phase does appear to passivate in the crack environment thereby confining the crack to the subgrain boundary region. This active path is enabled when cracks are isolated from a bulk environment, but is disabled otherwise. Potential and pH conditions required for cracking are discussed as is the formation of a hydrotalcite $Li_2[Al_2(OH)_6]_2 \cdot CO_3 \cdot 3H_2O$ film that appears to be responsible for passivating crack walls.

6998 (SAND–93-1146C) **In situ x-ray reflectivity measurements of thin film structural evolution.** Chason, E. (Sandia National Labs., Albuquerque, NM (United States)); Chason, M. Sandia National Labs., Albuquerque, NM (United States). [1993]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9311104–7: 40. national symposium of the American Vacuum Society (AVS), Orlando, FL (United States), 15-19 Nov 1993). Order Number DE94002289. Source: OSTI; NTIS; GPO Dep.

X-ray reflectivity using energy dispersive X-ray detection has been used to investigate vacuum deposited thin films. A resolution of 0.3 nm for thickness in the range of 3–200 nm and of 0.05 nm for roughness in the range of 0.1–3 nm has been demonstrated. Further, it is shown that by using energy dispersive detection, spectra can be obtained in less than 500 s allowing real time studies to be performed. Thin, discrete Cr/Al deposits on quartz substrates have been investigated and the presence of a 1.5 nm thick Al/Cr intermetallic layer formed during room temperature deposition has been determined. During annealing at 250 C, the Cr layer thickness decreases linearly with time until approximately 4 nm is consumed in additional intermetallic formation; further annealing does not change the Cr layer thickness.

6999 (SAND–93-1171C) **Investigation of plasma etch induced damage in compound semiconductor devices.** Shul, R.J. (Sandia National Labs., Albuquerque, NM (United States)); Lovejoy, M.L.; Hetherington, D.L.; Rieger, D.J.; Vawter, G.A.; Klem, J.F.; Melloch, M.R. Sandia National Labs., Albuquerque, NM (United States). 1993. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9311104–10: 40. national symposium of the American Vacuum Society (AVS), Orlando, FL (United States), 15-19 Nov 1993). Order Number DE94002849. Source: OSTI; NTIS; GPO Dep.

We have investigated the electrical performance of mesa-isolated GaAs pn-junction diodes to determine the plasma-induced damage effects from reactive ion and reactive ion beam etching. A variety of plasma chemistries ($SiCl_4$, BCl_3, BCl_3/Cl_2, and Cl_2) and ion energies ranging from 100 to 400 eV were studied. We have observed that many of the RIE BCl_3/Cl_2 plasmas and RIBE Cl_2 plasmas yield diodes with low reverse-bias currents that are comparable to the electrical characteristics of wet-chemical-etched devices. The reverse-bias leakage currents are independent of surface morphology and sidewall profiles.

7000 (SAND–93-1720) **Structural analysis of a frangible nut used on the NASA Space Shuttle.** Metzinger, K.E. Sandia National Labs., Albuquerque, NM (United States). Nov 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94003672. Source: OSTI; NTIS; GPO Dep.

A structural analysis methodology has been developed for the NASA 2.5-inch frangible nut used on the Space Shuttle. Two of these nuts are used to secure the External Tank to the aft end of the Orbiter. Both nuts must completely fracture before the Orbiter can safely separate from the External Tank. Ideally, only one of the two explosive boosters contained in each nut must detonate to completely break a nut. However, after an uncontrolled change in the Inconel 718 material processing, recent tests indicate that in certain circumstances both boosters may be required. This report details the material characterization and subsequent structural analyses of nuts manufactured from two lots of Inconel 718. The nuts from the HSX lot were observed to consistently separate with only one booster, while the nuts from the HBT lot never completely fracture with a single booster. The material characterization requires only tensile test data and the determination of a tearing parameter based on a computer simulation of a tensile test. Subsequent structural analyses using the PRONTO2D finite element code correctly predict the differing response of nuts fabricated from these two lots. This agreement is important because it demonstrates that this technique can be used to screen lots of Inconel 718 before manufacturing frangible nuts from them. To put this new capability to practice, Sandia personnel have transferred this technology to the Pyrotechnics Group at NASA-JSC.

7001 (SAND–93-2168C) **High temperature grain growth and oxidation of Fe-29Ni-17Co (Kovar™) alloy leads.** Stephens, J.J.; Greulich, F.A.; Beavis, L.C. Sandia National Labs., Albuquerque, NM (United States). [1993]. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9211117–12: Minerals, Metals, and Materials Society/American Society for Metals (TMS/ASM) materials week '92, Chicago, IL (United States), 2-5 Nov 1992). Order Number DE94004691. Source: OSTI; NTIS; GPO Dep.

One important application for the Fe-29Ni-17Co (Kovar™) alloy in wire form is in brazed feed through assemblies which are integral parts of vacuum electronic devices. Since Cu metal brazes are performed at process temperatures of about 1100°C, there is opportunity for significant grain growth to occur during the brazing operation. Additional high temperature exposure includes decarburization of the Fe-29Ni-17Co alloy wire in wet hydrogen for 30 min. at 1000°C prior to the Cu brazing operation. Two approaches have been used to characterize grain growth in two lots of Fe-29Ni-17Co alloy: (1) a once-through processing study to study the effect of one-time-only device thermal processing on the resulting grain size, and (2) an isothermal grain growth study involving various times at 800–1100°C. The results of the once-through processing study indicate that acceptable grain sizes are obtained from both cold worked and mill-annealed wire lots following Cu brazing. The isothermal grain growth study indicates that the linear intercept distance for Fe-29Ni-17Co can be described with a power law function of time, and that thermal exposure must be controlled at temperatures in excess of 900°C in order to avoid excessive grain growth. A second study has characterized the oxidation kinetics of Fe-29Ni-17Co alloy wire in air at temperatures ranging from 550–700°C. This study indicates the parabolic growth law applies for this material, and between 550 and 700°C, oxidation in this alloy occurs at an activation energy of 27.9 kcal/mole. Other oxidation studies at higher temperatures (≥750°C) indicate an activation energy of 52.2 kcal/mole for oxidation of Fe-29Ni-17Co alloy at temperatures greater than 790°C. Quantitative point analyses of

the oxide scale formed at 600°C suggest that a significant fraction of the scale is close to the stoichiometry of the Fe_2O_3-type oxide.

7002 (SAND–93-2205C) **Issues for conversion coating of aluminum alloys with hydrotalcite.** Drewien, C.A.; Buchheit, R.G. Sandia National Labs., Albuquerque, NM (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940222–6: Corrosion 94: National Association of Corrosion Engineers (NACE) international annual conference, Baltimore, MD (United States), 28 Feb - 4 mar 1994). Order Number DE94003804. Source: OSTI; NTIS; GPO Dep.

Hydrotalcite coatings on aluminum alloys are being developed for corrosion protection of aluminum in aggressive saline environments. Coating bath composition, surface pretreatment, and alloying elements in aluminum all influence the performance of these coatings during salt spray testing. The coating bath, comprised of lithium carbonate, requires aging by dissolution of aluminum into the bath in order to grow corrosion resistant coatings. Coatings formed in non- aged baths do not perform well in salt spray testing. The alloying elements in aluminum alloys, especially copper, influence the coating growth and formation leading to thin coatings. The effect of the alloy elements is to limit the supply of aluminum to the coating/electrolyte interface and hinder growth of hydrotalcite upon aluminum alloys.

7003 (SAND–93-2334C) **Isothermal corrosion testing of steels in molten nitrate salts.** Prairie, M.R. (Sandia National Labs., Albuquerque, NM (United States)); Dunkin, S.R.; Chavez, J.M.; Bradshaw, R.W.; Goods, S.H. Sandia National Labs., Albuquerque, NM (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940326–5: American Society of Mechanical Engineers (ASME) international solar energy conference, San Francisco, CA (United States), 27-30 Mar 1994). Order Number DE94004695. Source: OSTI; NTIS; GPO Dep.

Tests were performed to evaluate the corrosivity of several nitrate salt mixtures on the containment materials likely to be used in a molten-salt solar central receiver power plant. Objective was to determine if common salt impurities (e.g., chloride) aggravate corrosion. The test was conducted for 7008 hours on A36 carbon steel at 320C and 304 and 316 stainless steels at 570C. Seven salt mixture containing a variety of impurity concentrations were used. Corrosion rates were determined by descaled weight loss for coupons removed periodically from the melts. The nitrate mixtures were analyzed for changes in impurity levels and accumulation of soluble corrosion products. Test results indicate generally that corrosion is slow and that impurities do not contribute dramatically to corrosion rates of carbon and stainless steels.

7004 (SAND–93-8237) **A materials compatibility study in FM-1, a liquid component of a paste extrudable explosive.** Goods, S.H. (Sandia National Labs., Livermore, CA (United States)); Shepodd, T.J.; Mills, B.E.; Foster, P. Sandia National Labs., Livermore, CA (United States). Sep 1993. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DR00789. Order Number DE94001166. Source: OSTI; NTIS; GPO Dep.

The chemical compatibility of various metallic and organic containment materials with a constituent of a paste extrudable explosive (PEX) has been examined through a series of long-term exposures. Corrosion coupons and mechanical test specimens (polymers only) were exposed to FM-1, a principal liquid component of PEX, at 74°C. RX-08-FK is the LLNL designator for this formulation. Compatibility was determined by measuring changes in weight, physical dimensions, and mechanical properties, by examining the coupons for discoloration, surface attack, and corrosion products, and by analyzing for dissolved metals in the FM-1. Of the metals and alloys examined, none of the 300 series stainless steels exhibited adequate corrosion resistance after 74 days of exposure. Copper showed evidence of severe uniform surface attack. Monel 400 also exhibited signs of chemical attack. Nickel and tantalum showed less evidence of attack, although neither, was immune to the liquid. Gold coupons developed a "tarnish" film. The gold along with an aluminum alloy, 6061 (in the T6 condition) performed the most satisfactorily. A wide range of polymers were tested for 61 days at 74°C. The materials that exhibited the most favorable response in terms of weight change, dimensional stability, and mechanical properties were Kalrez, PTFE Teflon, and polyethylene.

7005 (SAND–94-8475C) **Phase stability in the Cd-Mg system.** Asta, M. (Sandia National Labs., Livermore, CA (United States)); McCormack, R.; de Fontaine, D. Sandia National Labs., Livermore, CA (United States); Lawrence Berkeley Lab., CA (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DR00789 ; AC03-76SF00098. (CONF-931009–17: Fall meeting of the Minerals, Metals and Materials Society: physical metallurgy and materials, Pittsburgh, PA (United States), 17-21 Oct 1993). Order Number DE94004976. Source: OSTI; NTIS; GPO Dep.

This paper reports on results of a theoretical study of solid-state phase equilibria and short-range order in Cd-Mg alloys. Results of first-principles linear muffin-tin orbital method total-energy calculations for seven hcp-based superstructures have been combined with cluster-variation-method calculations of thermodynamic properties in order to compute the Cd-Mg phase diagram. Effect on the calculated phase diagram of contributions to the alloy free energy arising from atomic vibrations and structural relaxations are assessed using available experimental information for ordered and disordered alloys in the Cd-Mg system.

7006 (SVF–476) **Erosion testing of CRC 262.** Engman, U. (Studsvik Material AB, Nykoeping (Sweden)). Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Sep 1993. 29p. (In Swedish). Order Number DE94730448. Source: OSTI; NTIS.

Solid particle erosion (SPE) testing was made on Sandvik CRC 262 with different heat treatments and on the steels Type 321 and 15Mo3. The Studsvik Erofuge, a centrifugal erosion tester, was used and the testing was performed in air at room temperature. Alumina and olivine sand particles were used at a particle velocity of 60 m/s and at impingement angles of 60 degrees and 90 degrees. Differences in erosion resistance were obtained for CRC 262 depending on the heat treatment. Olivine sand resulted in lower erosion of CRC 262 than when using alumina. The particle type dependence is low for the other materials, Tp 321 and 15Mo3. CRC 262 has a slightly higher erosion resistance than Tp 321 and 15Mo3 and the differences are most pronounced when using olivine sand.

7007 (WAPD-T–2973) **An experimental study on the effects of compressive stress on the fatigue crack growth of low-alloy steel.** Jones, D.P. (Westinghouse Electric Corp., West Mifflin, PA (United States). Bettis Atomic Power Lab.); Hoppe, R.G.; Hechmer, J.L.; James, B.A. Westinghouse Electric Corp., West Mifflin, PA (United States). Bettis Atomic Power Lab. [1993]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-9306289–1: 1993 American Society of Mechanical Engineers (ASME) pressure vessel and piping conference, New Orleans, LA (United States), 21-25 Jun 1993). Order Number DE94004447. Source: OSTI; NTIS; INIS; GPO Dep.

A series of fatigue crack growth rate tests was conducted in order to study effects of negative stress ratio on fatigue crack growth rate of low-alloy steel in air. Four-point bend specimens were used to simulate linear stress distributions typical of pressure vessel applications. This type of testing adds to knowledge on negative stress ratio effects for low-alloy steels obtained in the past from uniform tension-compression tests. Applied bending stress range was varied over twice the yield strength. Load control was used for tests for which the stress range was less than twice the yield strength and deflection control was used for the higher stress range tests. Crack geometries were both short and long fatigue cracks started at notches and tight fatigue cracks for which crack closure could occur over the full crack face. Results are presented in terms of the stress intensity factor ratio $R = K_{MIN}/K_{MAX}$. The negative R-ratio test results were correlated to an equation of the form $da/dN = C[\Delta K/(A-R)]^n$, where A, C, and n are curve fitting parameters. It was found that effects of negative R-ratio on fatigue crack growth rates for even the high stress range tests could be bounded by correlating the above equation to only positive R-ratio test results and extending the resulting equation into the negative R-ratio regime.

7008 (WSRC-TR--93-474) **Effect of nitrocarburizing on shape of titanium alloy parts.** Clark, E.A. Westinghouse Savannah River Co., Aiken, SC (United States). 27 Sep 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004040. Source: OSTI; NTIS; GPO Dep.

Components are being developed for plutonium casting in support of Lawrence Livermore National Laboratory. A vendor used a proprietary process to grow a nitrocarburized surface layer on a titanium alloy shot sleeve to be used in a prototype die casting machine. The shot sleeve was significantly out-of-round upon return from the vendor and could not be used. Purpose of this study was to determine whether the shape change could have been caused by this surface treatment. Visual observation of disk and ring samples exposed first to surface treatment alone temperature and then the actual nitrocarburizing environment revealed no gross warping in either case. Dimension measurements of each sample before and after both the thermal treatment and the nitrocarburizing revealed no significant changes. Visual examination of the shot sleeve revealed a surface flaw likely made during handling after machining at SRS and before the part was nitrocarburized. The out-of-roundness of the shot sleeve could be related to the damage observed on the surface, but the possibility of warping during the nitrocarburizing cannot be excluded. Nitrocarburization should remain a candidate method to protect titanium alloys from molten metals.

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Refer also to citation(s) 6228, 6623, 6928, 6929, 6935, 6936, 6937, 6938, 6939, 6946, 6948, 6949, 6950, 6953, 6963, 7064, 7141, 7181, 7355, 7356, 7777, 7782, 7783, 7788, 7790

7009 (CONF-9305134--, pp. 16-23) **Stress-induced roughening instabilities along surfaces of piezoelectric materials.** Chien, N.Y. (Stanford Univ., CA (United States)); Gao, H. Argonne National Lab., IL (United States). 1993. DOE Contract FG03-91ER14196. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The possibility of using electric field to stabilize surfaces of piezoelectric solids against stress-induced morphological roughening is explored in this paper. Two types of idealized boundary conditions are considered: (1) a traction free and electrically insulating surface and (2) a traction free and electrically conducting surface. A perturbation solution for the energy variation associated with surface roughening suggests that the electric field can be used to suppress the roughening instability to various degrees. A completely stable state is possible in the insulating case, and kinetically more stable states can be attained in the conducting case. The stabilization has importance in reducing concentration of stress and electric fields due to microscopic surface roughness which might trigger failure processes involving dislocation, cracks and dielectric breakdown.

7010 (CONF-9305134--, pp. 116-123) **Measurements of the elastic constants of superlattice films by line-focus acoustic microscopy.** Achenbach, J.D. (Northwestern Univ., Evanston, IL (United States)); Kim, J.O.; Lee, Y.C. Argonne National Lab., IL (United States). 1993. DOE Contract FG02-86ER13484. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The effective elastic constants of single-crystal TiN/NbN (001) superlattices have been determined using line-focus acoustic microscopy. Two independent procedures to determine the elastic constants of the superlattices are discussed. The first procedure calculates the effective elastic constants of the TiN/NbN superlattices from the elastic constants of the constituent TiN and NbN layers and verifies the calculated elastic constants by comparing the corresponding calculated SAW dispersion curves with measured dispersion curves. In the second procedure the effective elastic constants of the TiN/NbN superlattices are determined from the measured SAW dispersion data of the superlattices deposited on MgO substrates. The accuracy of each constant is estimated by considering the sensitivity of the dispersion curves to changes of each constant. The results of the two procedures are compared and advantages and disadvantages of each procedure are discussed.

7011 (CONF-9305134--, pp. 124-130) **Superconducting property measurements in tape geometry.** Telschow, K.L. (Idaho National Engineering Lab., Idaho Falls, ID (United States)). Argonne National Lab., IL (United States). 1993. DOE Contract AC07-76ID01570. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Fabrication of the new high T_c superconductor materials into useable long-length wires or tapes has proven difficult, often resulting in low critical currents. The ability to measure critical currents in high T_c superconducting tapes on a local scale can be valuable for assessing the microstructure resulting from the fabrication process. This paper describes the results of research on using induced currents from a small noncontacting electromagnetic probe to determine the critical current density in high T_c tapes on a local scale. The technique forces full-field penetration into the tape locally and infers the local critical current density from the "critical state" model for flux penetration. Difficulties encountered with the tape geometry and demagnetization effects are overcome by an analysis procedure that provides comparative measurement of the critical current density with the contacting DC transport probe method. Results for several tapes with different critical currents are discussed.

7012 (CONF-9305134--, pp. 131-138) **Photothermal measurements of superconductors.** Kino, G.S. (Stanford Univ., CA (United States)); Wu, X.D.; Kapitulnik, A.; Fishman, I. Argonne National Lab., IL (United States). 1993. DOE Contract FG03-90ER14157. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The authors have developed a new photothermal technique to investigate electronic phase transitions of high temperature superconductors. The phase shift of the thermal wave yields the anisotropic thermal diffusivity coefficient of the sample. The amplitude of the photothermal signal is sensitive to electronic phase transitions of the second kind. The technique is completely noncontacting and nondestructive, and is well suited to measure small and fragile single-crystal high-T_c superconductors. The measurements give good agreement with fluctuation theory near the transition temperature. They have studied diffusion in, and superconducting fluctuations of, single crystals of $YBa_2Cu_3O_{7-\delta}$ and $Bi_2Sr_2CaCu_2O_8$. Both systems show fluctuation effects beyond Gaussian fluctuations. While $YBa_2Cu_3O_{7-\delta}$ behaves as a three-dimensional anisotropic superconductor, results on $Bi_2Sr_2CaCu_2O_8$ indicate strong two-dimensional effects.

7013 (CONF-9305316--) **Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.** No corporate text available. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

The present proceedings includes two special presentation papers and 23 general presentation papers. The special presentations are ' Energy problems and thermal spraying ' and ' Thermally sprayed coatings for high temperature environments '. The general presentations consist of five presentations as to metal materials, such as TiC/TiAl composite layer, multi coated steel, Fe-C base alloy deposits, SUS440C/Ag composite coatings, and metal/ceramics mixed powders, six presentations as to evaluation techniques of thermal spraying through the scanning vibrating electrode method

and the thermal shock testing method, six presentations as to ceramic cermets, such as ZrO2-CeO2 base sprayed coatings, chromium oxide powder, WC-12%Co coating, and Ni/ZrO2 mechanically alloyed composite powders, four presentations as to anti-corrosion techniques by using the multi-layer coating processing, anti-corrosion metal spraying layer, and plasma sprayed coatings, and two presentations as to thermal spraying methods, such as high speed arc spray process and TOP GUN spraying system. 117 refs., 143 figs., 38 tabs.

7014 (CONF-9305316–, pp. 16-19) **Characterization of electrostatic separation for metal/ceramics mixed powders.** Ogino, K. (Toyohashi University of Technology, Aichi (Japan)); Okane, I. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

A new and better reactive plasma spraying process has been developed by addition of an electrostatic separator to spraying process. This new process depends on possibiiity of getting high reactivity of ceramics. The purpose of this study is to examine the characteristics of electrostatic separation for metal/ceramics mixed powders, fundamentally, and to evaluate the feasibility of separation with the electrostatic separation method. For the experiments, Al2O3 powders with diameter of 21.5μm and CuO powders with diameter of 19.6μm were used as reactive particles, and Al powders with diameter of 73.6μm and Cu powders with diameter of 34.5μm were used as non-reactive particles. Consequently, it was revealed that the characteristics of electrostatic separation depend on shapes, size and kinds of particles used. Furthermore, to obtain high efficiency of separation, it was necessary that ceramics powders adhere to electrodes as many as possible. 5 refs., 5 figs., 3 tabs.

7015 (CONF-9305316–, pp. 34-37) **Observation of deformation and fracture of thermal spray coatings.** Tobe, S. (Ashikaga Institute of Technology, Tochigi (Japan)); Misawa, H.; Akita, K.; Kon, Y. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

Tensile and shear tests of some thermal spray coatings have been carried out under the observations using optical microscope and SEM (scanning electron microscope). The Fe based MG50 was used for are spraying, Cr2O3 and Mo were used for air plasma spraying, and Cr2O3, Mo, and Ni-Cr for low pressure plasma spraying. The SS400 having the width of 15mm, length of 45mm, and thickness ranging from 2mm to 4mm was used as substrate material. It was shown that many microcracks were initiated at the interface of lamella when low level of the external stress was applied to the coatings. The AE (acoustic emission) tests were also conducted on the coatings. Consequently, it was found that a lot of the events which had quite low amplitude were generated. On the other hand, it was found that the hit number was rather small. An adequate qualitative agreement between the microscopic observation and the AE test was obtained. 6 figs., 2 tabs.

7016 (CONF-9305316–, pp. 38-41) **Relationship between coating adhesion strength and substrate temperatures.** Murakami, H. (Toyohashi Univ. of Technology, Aichi (Japan)); Fukumoto, M.; Okane, I.; Harada, H. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

In the evaluation of thermally sprayed coating, adhesion property is one of the most essential properties. However, simple and accurate method for evaluating the adhesion of thick coating has not been established yet. In this study, ring shearing type test was adopted, and some modifications were proposed. In order to find the moderate testing conditions, influence of main factors relating to the shearing test was fundamentally investigated. The resultant stress distribution in the coating was analyzed by FEM (finite element method) in this research. The relation between coating adhesion and substrate temperature was investigated by this evaluation method. Consequently, it was confirmed that the ring type shear strength evaluation method is useful as an evaluation method of adhesion strength of thermally sprayed coating when the factors, such as coating width, coating thickness, and clearance between substrate and jig, are set adequately. Furthermore, it was revealed that the shear strength increases with increasing the substrate temperature. 1 ref., 8 figs., 2 tabs.

7017 (CONF-9305316–, pp. 42-45) **Adhesive strength of ceramic coatings sprayed on controlled roughned surfaces.** Amada, s. (Gunma University, Gunma (Japan)); Katakura, H.; Yamada, H. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

The grit blasting technique is widely used for the pre-treatments of coating substrates. Since the blasted surfaces are randomly roughened, it is very difficult to predict the generating mechanism of the adhesive strength of coatings. In order to solve this problem, the controlled roughened surfaces were prepared by the machining using a shaper. Four kinds of roughened surfaces with different surface roughnesses were made by changing the cutting amount with the shaper. The surface roughness was measured by using a roughness gauge. It was found that the surface area of substrate increases in proportion to the depth of cut. Then, the alumina coatings were formed on the roughened surfaces of substrates through the plasma spraying. For the plasma spraying, alumina powders with the average size of 20μm were used. The adhesive strength of coating was measured by the tensile test. Consequently, it was revealed that the adhesive strength is proportional to the contact area between substrates and coatings. 5 refs., 8 figs., 2 tabs.

7018 (CONF-9305316–, pp. 54-57) **Effect of spraying parameters on the property of ceria stabilized zirconia coating.** Sodeoka, S. (Government Industrial Research Institute, Osaka (Japan)); Ueno, K.; Inoue, T. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Available from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

Plasma sprayed coatings of ZrO2-50mol%CeO2 were fabricated with various plasma powers. Then, were evaluated the properties of coatings, as for density, composition, crystal phase, Vickers microhardness, thermal expansion coefficient, specific heat, thermal diffusivity, and thermal conductivity. The density of coatings was measured by the Archimedes' method. Compositional analysis and identification of crystal phase of coatings were carried out by the fluorescence X-ray method and X-ray diffraction method, respectively. In addition, were conducted measurement of Vickers microhardness, measurement of thermal expansion coefficient from room temperature to 1,300 centigrade, and measurements of specific heat, thermal diffusivity, and thermal conductivity up to 800 centigrade by the laser flash method. Consequently, it was found that the porosity of the coatings decreased and the Vickers microhardness increased with increasing the plasma power. However, there was no significant difference about the thermal expansion coefficient and thermal conductivity as far as this experiment. 1 ref., 8 figs., 1 tab.

7019 (CONF-9305316–, pp. 58-61) **Chromium oxide powder for thermal spraying.** Tamamaki, M. (Japan Abrasive Co. Ltd., Osaka (Japan)); Fujii, S.; Tsuda, K.; Hayashi, H. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of*

Japan Thermal Spraying Society. Order Number DE94731734. Source: OSTI; NTIS; Available from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

A new type of chromium oxide powder for thermal spraying has been synthesized with catalyst effect and heat treatment. Properties of the prepared powder and performance of the thermally sprayed coatings were investigated. The chromium oxide powder obtained was compared with the conventional fused crushed powder, which is currently applied. For the new type of chromium oxide powder, particle has roughly spherical shape with no sharp edge. This powder, therefore, has good fluidity. Content of chromium metal as impurity having influence in adverse on properties of coatings is less than 0.1%, which is very low level. Furthermore, to examine the characteristics of thermally sprayed coatings using this powder, this powder was plasma sprayed on the SUS304 steel surface using argon and hydrogen as working gases. Consequently, it was demonstrated that the plasma sprayed coatings using this powder have high hardness, good wear resistance and good anti-erosion, and bring in smooth finished surface. 5 figs., 2 tabs.

7020 (CONF-9305316–, pp. 62-65) **Structure and wear resistance property of high velocity combustion flame sprayed WC-12%Co coating.** Shimizu, Y. (Shinshu University, Nagano (Japan). Faculty of Engineering); Sato, M.; Sato, H. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Available from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

Microstructure, crystal structure, microhardness and wear resistance property of high velocity combustion flame sprayed WC-12%Co coatings were investigated, which were fabricated under various spraying conditions. These coating properties were compared with those of a commercial sintered WC-Co alloy used for dies. The high velocity combustion flame spraying was carried out under such a condition as fuel propylene gas flows of 42 l/min, oxygen gas flows of 430 l/min, and spraying distance at 200 mm. Microstructures of sprayed coatings, sintered WC-Co alloys, and worn surfaces after wearing test were observed by the SEM (scanning electron microscope) and EPMA (electron probe X-ray microanalyzer). Crystal structure was analyzed by the X-ray diffraction method. Microhardness of the coating was measured by the Vickers microhardness meter. Wear resistance property was evaluated by the Savin type dry wearing test machine. Consequently, it was demonstrated that the WC-12%Co coatings provide a superior wear resistance to that of the sintered WC-Co alloy. 2 refs., 5 figs., 1 tab.

7021 (CONF-9305316–, pp. 66-69) **Thoughts on the WC/Co coatings by HVAF.** Akimoto, K. (Yosha Giken Co. Ltd., Osaka (Japan)); Akimoto, K.; Mitani, K.; Fujii, H. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Available from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

The WC/Co coatings prepared by high velocity coating system are suffered their properties from chemical changes, such as decarburization and matrix oxidation during spraying. This is not exceptional also on the D-gun process. In this paper, properties of WC/Co coatings are compared with each other, which were prepared by the D-gun process, HVOF process, and HVAF process. Decarburization and oxidation of sprayed coatings were examined by the X-ray diffraction method. For the coatings by the D-gun process and HVOF process, decomposition of WC was detected. On the other hand, for the coatings by the HVAF process, decomposition of WC was negligible. In addition, for the coatings by the HVAF process, the chemical decomposition was not found by the SEM (scanning electron microscope) observation. Furthermore, hardness of the coatings by the HVAF process was the highest. Accordingly, it was found that the WC/Co coatings by the HVAF process were essentially unchanged. 7 figs., 1 tab.

7022 (CONF-9305316–, pp. 70-73) **Plasma spraying of Ni/ZrO2 mechanically alloyed composite powders.** Negoro, K. (Toyohashi Univ. of Technology, Aichi (Japan)); Fukumoto, M.; Okane, I.; Kito, M.; Fukami, S. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Available from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

In this paper, interest has focused on applying Ni/ZrO2 material to fuel electrode of SOFC (solid oxide fuel cell). The Ni/ZrO2 composite powders were prepared by mechanical alloying (MA) process using a rotary ball mill. Then, the obtained powder was plasma sprayed. Sectional structure of the obtained spray coating was observed by the SEM (scanning electron microscope) and EPMA (electron probe X-ray microanalyzer). For the non-oxidized MA powder, the separation phenomena of Ni phase from ZrO2 phase were observed. For the pre-oxidized MA powder, on the other hand, homogeneous coating structure of Ni/ZrO2 was made. It was suggested that improvement of wettability by the oxide layer is effective to the suppression of the separation. As a result, the possibility of applying pre-oxidized Ni/ZrO2 MA powder to the fabrication of SOFC electrode was found out. 5 refs., 5 figs., 4 tabs.

7023 (CONF-9305316–, pp. 74-77) **Application of MA composite powder spraying for solid oxide fuel cell.** Kito, M. (Onoda Cement Co. Ltd., Tokyo (Japan)); Fukami, S.; Negoro, K.; Fukumoto, M.; Okane, I. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

The Ni/YSZ cermet film is applied to a fuel electrode layer of the SOFC (solid oxide fuel cell), which is expected to be a highly efficient and almost pollution-free electric generator. Generally, the fuel electrode layer is formed by EVD (electrochemical vapor deposition) process, gas flame spraying process, etc. However, it is difficult to stabilize the microstructure and the mixing ratio of Ni/YSZ cermet film by these processes. As a part of development of SOFC by atmospheric plasma spraying, in this paper, the plasma spraying using the composite powder prepared by the mechanical alloying (MA) process was applied for forming a fuel electrode layer. Consequently, homogeneously mixed composite film was obtained. In addition, excellent electric conductivity and coefficient of linear expansion were obtained by selecting the optimal mixing ratio. Accordingly, the possibility of applying Ni/YSZ MA powder to the fabrication of SOFC electrode was found out. 9 refs., 3 figs., 2 tabs.

7024 (CONF-931108–18) **Deposition of a-SiC:H using organosilanes in an argon/hydrogen plasma.** Maya, L. Oak Ridge National Lab., TN (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Fall meeting of the Materials Research Society (MRS); Boston, MA (United States); 29 Nov - 3 dec 1993. Order Number DE94004428. Source: OSTI; NTIS; INIS; GPO Dep.

Selected organosilanes were examined as precursors for the deposition of amorphous hydrogenated silicon carbide in an argon/hydrogen plasma. Effect of process variables on the quality of the films was established by means of FTIR, Auger spectroscopy, XPS, XRD, chemical analysis, and weight losses upon pyrolysis. For a given power level there is a limiting feeding rate of the precursor under which operation of the system is dominated by thermodynamics and leads to high quality silicon carbide films that are nearly stoichiometric and low in hydrogen. Beyond that limit, carbosilane polymer formation and excessive hydrogen incorporation takes place. The hydrogen content of the plasma affects the deposition rate and the hydrogen content of the film. In the thermodynamically dominated regime the nature of the precursor has no effect on the quality of the film, it affects only the relative utilization efficiency.

7025 (CONF-9311131–2) **Thermal conductivities, electrical resistivities, and Seebeck coefficients of $YBa_2Cu_3O_{7-x}$ superconductors from 80 to 300 K.** Yarbrough, D.W. (Oak Ridge National Lab., TN (United States)); Williams, R.K.; Shockley, D.R. Oak Ridge National Lab., TN (United States). [1993]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 22. international thermal conductivity conference; Tempe, AZ (United States); 7-10 Nov 1993. Order Number DE94004796. Source: OSTI; NTIS; GPO Dep.

Thermal conductivities, electrical resistivities, and Seebeck coefficients of three polycrystalline $YBa_2Cu_3O_{7-x}$ specimens have been measured over the temperature range 80 to 300 K in a longitudinal-heat-flow apparatus. Smoothed values for thermal conductivity, and electrical resistivity have been obtained for temperatures above the superconducting transition temperature of 90 K. The thermal conductivity values decreased as the temperature was increased, a trend which is inconsistent with the results of some other investigators. The thermal conductivities were less than previously published values and it is suggested that these differences are due to radiative heat loss in the published values. This effect is especially important for linear heat flow measurements on low thermal conductivity materials. The electrical and thermal conductivities of the specimens varied with Ba content and this variation was used to separate the thermal conductivity into lattice and electronic components are significant. The phonon component exhibits the expected temperature variation and an analysis indicates that the electron-phonon interaction is unusually strong.

7026 (DOE/FTR–94001874) **Travel to Japan for symposium on boron, borides, and related compounds: Foreign trip report, August 20–September 15, 1993.** Switendick, A.C. Sandia National Labs., Albuquerque, NM (United States). 12 Oct 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE94001874. Source: OSTI; NTIS (US Sales Only); GPO Dep.

During this trip I was able to attend two meetings and fulfill an opportunity to present an invited lecture. At the 11th International Conference on Boron, Borides and Related Compounds in Tsukuba, Japan, I presented an invited talk. I also had numerous discussions with attendees on scientific issues and possible future interactions. At the 3rd International Conference on Advanced Materials, I presented a paper in Symposium I, "Hydrogen Absorbing Materials and Hydride Materials" and attended several other symposia. I also visited Prof. Suda 's laboratory in Kogakuin University and had varied interactions with several of his colleagues and students which included several invitations to visit China. Finally, I was able to accept an invitation tendered at the Gordon Conference in July by Prof. K. Tanaka of the Department of Materials Science and Engineering of Nagoya Institute of Technology to present a lecture at his Institute.

7027 (ECN-RX–93-106) **Development of a predictive grinding model for the high-quality machining of engineering ceramics.** Saurwalt, J.J. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Nov 1993. 35p. Order Number DE94729852. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

To be presented at the 5th International Grinding Conference, Cincinnati, Ohio, USA, October 26-28, 1993.

Machining of ceramics not only generates dimensional tolerances but also influences the surface integrity. The use of a low grain depth of cut results in a surface layer with small or no cracks. A parameter which is proportional to the thickness of cut due to grinding parameters, has unique relations with grinding forces, resulting bending strength and residual stresses. On this relation a predictive grinding model can be based. The large amount of factors influencing grinding, especially wear and run out of the wheel, restricts the use of the model. Creep feed conditions combine high removal rates with low thickness of cut and low damage, but are very sensitive to the grinding set up. 16 figs., 1 tab., 13 refs.

7028 (IS-T–1631) **Investigation of the phase equilibria and phase transformations associated with the $Bi_2Sr_2CaCu_2O_y$ superconductor.** Holesinger, T. Ames Lab., IA (United States). 9 Dec 1993. 172p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94004889. Source: OSTI; NTIS; INIS; GPO Dep.

The solid solution region and reaction kinetics of the $Bi_2Sr_2CaCu_2O_y$ (2212) superconductor were examined as a function of temperature and oxygen partial pressure. Crystallization studies from the glassy and molten states were undertaken to determine the phase transformation and kinetics associated with the formation of 2212 and other competing phases. Crystallization of nominal 2212 glasses was found to proceed in two steps with the formation of $Bi_2Sr_{2-x}Ca_xCuO_y$ (2201) and Cu_2O followed by $Bi_2Sr_{3-x}Ca_xO_y$, CaO, and SrO. The 2212 phase converts from the 2201 phase with increasing temperatures. However, its formation below 800 C was kinetically limited. At 800 C and above, a nearly full conversion to the 2212 phase was achieved after only one minute although considerably longer anneal times were necessary for the system to reach equilibrium. In low oxygen partial pressures, the solidus is reduced to approximately 750 C. Solidification studies revealed an eutectic structure separating the incongruently melting 2212/2201 phases at high oxygen partial pressures from the congruently melting $Bi_2Sr_{3-x}Ca_xO_y$ (23x) and $Bi_2Sr_{2-x}Ca_xO_y$ (22x) phases present at low oxygen partial pressures. During solidification in various oxygen partial pressures, the separation of CaO in the melt and the initial crystallization of alkaline-earth cuprates leaves behind a Bi-rich liquid from which it is impossible to form single-phase 2212. Hence, significant amounts of 2201 were also present in these samples. These problems could be reduced by melt processing in inert atmospheres. Bulk 2212 material produced in this manner was found to possess high transition temperatures, high intergranular critical current densities below 20K, and modest critical current densities at 77K.

7029 (IS-T–1661) **Synthesis, characterization, phase diagrams and superconducting and normal state magnetic properties of $La_{2-x}Sr_xCuO_4$ ($0 \leq x \leq 0.08$) and electrochemically oxidized $La_{2-x}Sr_xCuO_{4+\delta}$ ($0 \leq x \leq 0.33$, $0 \leq \delta \leq 0.12$).** Chou, F. Ames Lab., IA (United States). Aug 1993. 157p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005260. Source: OSTI; NTIS; INIS; GPO Dep.

$La_{2-x}Sr_xCuO_4$ ($0 \leq x \leq 0.15$) can all be intercalated with oxygen by a novel electrochemical oxidation method. Bulk superconductivity is found with an onset $T_c \approx 40$ K for the whole range $0.01 \leq x \leq 0.15$; for x = 0.25 and 0.33, the electrochemical oxidation did not improve the superconducting properties. The magnetic susceptibility χ(T = 50–320 K) data for $La_2CuO_{4.11}$ and $La_{1.92}Sr_{0.08}CuO_{4.07}$ are nearly identical with those of conventionally prepared $La_{1.85}Sr_{0.15}CuO_4$, indicating that the hole doping level (p) in the CuO_2 planes of the three compounds is nearly the same. Combined thermogravimetric analysis and iodometric titration experiments indicate that part of the intercalated oxygen has a formal valence close to −1. The maximum doped-hole concentration in the CuO_2 planes that can be achieved from combined Sr-doping and electrochemical oxygen doping for $0 \leq x \leq 0.15$ is $p \approx 0.16$ holes/formula unit. Oxygen can also intercalate into single crystal La_2CuO_4 through a slow electrochemical oxidation process. The required low current and long time for the charging process reflects that the oxygen intercalation for a single crystal is limited by its small specific surface area and long diffusion distance. The anisotropic superconducting, magnetic and transport properties are summarized and compared with those of polycrystalline $La_2CuO_{4+\delta}$ as well as of $YBa_2Cu_3O_{7-\delta}$ and $La_{2-x}Sr_xCuO_4$ single crystals. The single crystal $La_2CuO_{4+\delta}$ has a maximum $T_c \approx$ 40 K, which is lower than that ($T_c \approx$ 42–45) of the corresponding polycrystalline samples. The magnetic phase diagram of $La_{2-x}Sr_xCuO_4$ in the antiferromagnetic (AF) regime ($0 \leq x \leq 0.02$) has been derived from ^{139}La NQR studies from 4 to 250 K.

7030 (LA-UR–93-3614) **The fracture behavior of a CVD crystalline Si_3N_4/amorphous Si_3N_4 composite.** Reimanis, I.E.; Petrovic, J.J.; Suematsu, H.; Mitchell, T.E. Los Alamos National Lab., NM (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931142–2: 1. meeting of the Pacific Rim ceramic societies,

Honolulu, HI (United States), 7-10 Nov 1993). Order Number DE94002646. Source: OSTI; NTIS; GPO Dep.

The mechanical properties of a chemically vapor deposited α-Si_3N_4/amorphous Si_3N_4 composite were examined at 25°C and up to 1400°C using a microhardness tester. The composite consists of an amorphous matrix containing elongated α-Si_3N_4 particles (5–50 μm in diameter) which in some cases are radially microcracked. The conditions for spontaneous microcracking due to thermal residual stress are derived for a cylinder embedded in a matrix. Heat treatment of the composite at 1200°C results in a microstructure where the matrix consists of nanometer-sized particles separated by thin (50 Å) layer of carbon. The indentation fracture toughness of the heat treated material improves remarkably due to extended microcracking through the carbon layer.

7031 (LA-UR–93-4230) **Fabrication and testing of plasma-spray formed $MoSi_2$ and $MoSi_2$ composite tubes.** Castro, R.G. (Los Alamos National Lab., NM (United States)); Hellman, J.R.; Segall, A.E.; Shelleman, D.L. Los Alamos National Lab., NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931108–35: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004995. Source: OSTI; NTIS; GPO Dep.

Plasma-spray forming has been used to fabricate thick-wall tubes of $MoSi_2$ and $MoSi_2$ containing concentric layers of Al_2O_3. This process is being investigated as a potential fabrication method for producing tubular components of $MoSi_2$ and $MoSi_2$ composites for use in high temperature fuel-burner applications. Results are reported on spray forming method used to produce various tube sizes. Room temperature strength of pure $MoSi_2$ tubes in the as-deposited condition, and after heat-treating at 1500 C for 2 hours in vacuum is also reported. Strength of plasma sprayed $MoSi_2$ tubes were measured via diametral compression of O-ring and C-ring sections in air at room temperature. Prediction of the strength distribution was based on Weibull statistical theory.

7032 (LA-UR–93-4326) **Damage growth in $MgAl_2O_4$ crystals by Xe ion irradiations.** Yu, Ning; Nastasi, M.; Hollander, M.G.; Evans, C.R.; Maggiore, C.J.; Sickafus, K.E.; Tesmer, J.R. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931108–31: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94005009. Source: OSTI; NTIS; GPO Dep.

We have studied damage kinetics in single crystal $MgAl_2O_4$ (spinel) with (l00) orientation under 370 keV Xe ion irradiations at temperatures of −100 and 400C. In-situ Rutherford Backscattering Spectrometry (RBS) and ion channeling have been used to monitor the damage accumulation in spinel following sequential Xe ion irradiations. A significant temperature effect on the irradiation damage has been found. Channeling data show that at −100C, the irradiated spinel layer reaches the same level as in a random spectrum at a dose of 8×10^{15} Xe/cm^2 (20 DPA for peak damage), while at 400C, the near surface region (50 nm) remains single-crystalline up to $2 \times l0^{l6}$ Xe/cm^2.

7033 (ORNL/FTR–4702) **Collaborative research on ion implantation of ceramics.: Foreign trip report, June 25–July 21, 1993.** McHargue, C.J. Oak Ridge National Lab., TN (United States). 29 Jul 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE93019177. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Discussions were held with members of The Royal Institution of Great Britain on theoretical calculations in ceramic crystals relating to our ion-implantation results. Experiments were conducted by the staff of the National Institute for Engineering and Industrial Research (MTI) on sapphire crystals ion implanted at Oak Ridge National Laboratory (ORNL). Results of each experiment were analyzed in order to determine conditions for the next one. The traveler discussed the results of recent experiments in France that are part of an ORNL University Claude Bernard collaboration in ion implantation of ceramics. Rain erosion and thermal shock tests on ORNL-supplied specimens of surface-modified sapphire and diamond have been completed at the Cavendish Laboratory. The traveler attended and presented an invited paper, "Ion Implantation-Induced Amorphization of Sapphire," at the International Conference on Mechanisms of Formation of Metastable Microstructures. Experiment details were discussed with Prof. T.F. Page for continuation.

7034 (ORNL/FTR–4819) **Travel to Germany to discuss structural ceramic research: Foreign trip report, September 29–October 9, 1993.** Tennery, V.J. Oak Ridge National Lab., TN (United States). 22 Oct 1993. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94002195. Source: OSTI; NTIS (US Sales Only); GPO Dep.

There is major activity in Germany on use of silicon nitride ceramics in reciprocating engines, bearings, seals, etc. understanding the microstructural features of these materials, which must be controlled via processing, to maximize the mechanical performance at high temperatures; and developing manufacturing processes and system that will greatly reduce cost of silicon nitride components. Large, coordinated activities are organized by Bundesministerium fuer Forschung und Technologie (BMFT). Many of the partnerships ongoing now within the Fraunhofer institute system, involving these materials, include 20 or more industrial partners plus three or more Fraunhofer institutes and often two or more university institutes. The Max Planck Institutes do not seem as involved in this activity, but pressure is increasing on these. Suggestions have been made that the Max Planck Institutes will have to establish such partnerships in future to continue to receive the level of federal government funding they have enjoyed. Impressive results have been achieved in Germany in large-scale evaluation of silicon nitride ceramics as engine valves and other engine components. Reliability of these materials has now evolved to the point where Germany engine designers actually consider these materials as possible replacements for metal. Major national projects are now under way focused on developing methods for more efficiently machining, particularly silicon nitride and silicon carbide, ceramics. A new type of machine tool has reportedly been developed by Daimler-Benz/Mercedes Benz for machining engine valves from "blanks" in times of about 90 s. Much work has been done in Germany on silicon nitride compositions to provide the needed reliability for these applications and the processing technology necessary for commercialization.

7035 (PNL-SA–21630) **Structure and properties of composites synthesized in situ using solid state displacement reactions.** Henager, C.H. Jr.; Brimhall, J.L. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 21p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931009–16: Fall meeting of the Minerals, Metals and Materials Society: physical metallurgy and materials, Pittsburgh, PA (United States), 17-21 Oct 1993). Order Number DE94004589. Source: OSTI; NTIS; GPO Dep.

Solid state displacement reactions can produce in situ intermetallic and ceramic matrix composites in a process where an intermetallic or ceramic phase(s) and a potential reinforcing phase(s) are grown together during a solid state reaction. Interpenetrating and dispersed microstructures, important for desirable composite properties, have been produced by means of displacement reaction processing techniques. Two such composites have been synthesized which exhibit two distinct microstructures: $MoSi_2$ reinforced with SiC particles, which exhibits a dispersed-phase structure, and NiAl/Ni_3Al reinforced with Al_2O_3, which exhibits an interpenetrating-phase structure. Strength in bending and chevron-notch fracture toughness have been determined as a function of temperature, and measured properties compare favorably with composites produced by other means. The measured properties are discussed with regard to the observed microstructures. The potential for displacement reaction processing is assessed, and it appears to be a cost-effective synthesis method compared to others.

7036 (PNL-SA–23284) **Bench-scale synthesis of nanoscale materials.** Buehler, M.F.; Darab, J.G.; Matson, D.W.; Linehan, J.C. Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931235–4: NASA

2003 conference, Anaheim, CA (United States), 7 Dec 1993). Order Number DE94004787. Source: OSTI; NTIS; GPO Dep.

A novel flow-through hydrothermal method used to synthesize nanoscale powders is introduced by Pacific Northwest Laboratory. The process, Rapid Thermal Decomposition of precursors in Solution (RTDS), combines high-pressure and high-temperature conditions to rapidly form nanoscale particles. The RTDS process was demonstrated on a laboratory scale and scaled up to accommodate production rates attractive to industry. The process is able to produce a wide variety of metal oxides and oxyhydroxides. The powders are characterized by scanning and transmission electron microscopic methods, surface-area measurements, and x-ray diffraction. Typical crystallite sizes are less than 20 nanometers, with BET surface areas ranging from 100 to 400 m^2/g. A description of the RTDS process is presented along with powder characterization results. In addition, data on the sintering of nanoscale ZrO_2 produced by RTDS are included.

7037 (SAND–93-2007) **Influence of lattice damage on retention and transport of deuterium in beta silicon carbide.** Wampler, W.R.; Causey, R.A. Sandia National Labs., Albuquerque, NM (United States). Oct 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DR00789. Order Number DE94005206. Source: OSTI; NTIS; GPO Dep.

Experiments were done to determine effect of lattice damage on solubility and transport of deuterium (D) in silicon carbide. Beta SiC samples were irradiated with energetic ions to produce lattice damage, and were then soaked in D_2 gas at 1000C. Concentration of D versus depth was then measured by nuclear reaction analysis. Very near the surface ($<0.5\mu m$), concentration of D was larger in irradiated than in unirradiated, but beyond 1 μm the D concentrations were similar ($\sim 20 \pm 10$ atomic ppM), even though the damage extended to 2.2 μm in most of the samples. Results from this study of ion-irradiated SiC together with our previous study of tritium migration in undamaged SiC point to the conclusion that uptake of D from gas into SiC occurs by transport along grain boundaries, whereas uptake of D into lattice damage produced by ion irradiation, and release of energetically implanted D both require permeation of D within grains which is much slower.

7038 (SAND–93-2495C) **Electronic charge distribution of sodium substituted palladium hydride, $NaPd_3H_2$.** Switendick, A.C. Sandia National Labs., Albuquerque, NM (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9308122–17: International Union of Materials Research Societies on advanced materials, Tokyo (Japan), 31 Aug - 4 sep 1993). Order Number DE94003767. Source: OSTI; NTIS; GPO Dep.

The calculated valence charge density of the recently synthesized $NaPd_3H_2$ compound is compared with that of palladium hydride, PdH, from which it can be derived.

7039 (SAND–93-2545C) **Adsorption and desorption studies of cesium on sapphire surfaces.** Zavadil, K.R. (Sandia National Labs., Albuquerque, NM (United States)); Ing, J.L. Sandia National Labs., Albuquerque, NM (United States). [1993]. 8p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940101–27: 11. symposium on space nuclear power systems, Albuquerque, NM (United States), 9-13 Jan 1994). Order Number DE94003798. Source: OSTI; NTIS; GPO Dep.

Adsorption/desorption were studied using combined surface analytical techniques. An approximate initial sticking coefficient for Cs on sapphire was measured using reflection mass spectrometry and found to be 0.9. Thermal Desorption Mass Spectrometry (TDMS) and Auger Electron Spectroscopy (AES) were used to verify that a significant decrease in sticking coefficient occurs as the Cs coverage reaches a critical submonolayer value. TDMS analysis demonstrates that Cs is stabilized on a clean sapphire surface at temperatures (1200 K) in excess of the temperatures experienced by sapphire in a TOPAZ-2 thermionic fuel element (TFE). Surface contaminants on sapphire can enhance Cs adsorption relative to the clean surface. C contamination eliminates the high temperature state of Cs desorption found on clean sapphire but shifts the bulk of the C desorption from 400 to 620 K. Surface C is a difficult contaminant to remove from sapphire, requiring annealing above 1400 K. Whether Cs is stabilized on sapphire in a TFE environment will most likely depend on relation between surface contamination and surface structure.

7040 (TRITA-FTE–93-3) **Superconducting thin films of $YBa_2Cu_3O_{7-x}$.** Hudner, J. Royal Inst of Tech. Stockholm (Sweden). Dept. of Solid State Electronics. 1993. 87p. Order Number DE94608744. Source: OSTI; NTIS; INIS.

Thin films of $YBa_2Cu_3O_{7-x}$ (YBCO) are significant in fundamental studies of oxide superconductors and for prospective electronic applications based on superconductors operating at 77 K. Synthesis of YBCO thin films is complex and a large part of this thesis has been devoted to elaborating various techniques in forming YBCO thin films. It was observed that synthesis of YBCO films exhibiting high zero-resistivity temperatures (T_c) $\geq$ 88 K and elevated critical current densities (J_c) $\geq 10^6$ A/cm^2 at 77 K was possible under widely different conditions of film growth. For the BaF_2-based method, various substrate materials were investigated. Among perovskite related substrates with low losses in the high frequency regime, $LaA10_3$ was found to yield YBCO films exhibiting the highest quality electrical properties. A study of YBCO film interaction with sapphire substrates was performed. It was suggested that the YBCO film on sapphire consists of weakly coupled superconducting grains. Compositional effects of Y, Ba and Cu for MOCVD-YBCO films were examined with respect to morphology, structure, resistivity, as susceptibility and $J_c(T)$. High T_c's and J_c's were observed for an anomalous large compositional range of Cu in off-compositional YBCO films. This was shown to be related to the formation of Cu-rich precipitates embedded within a c-Axis oriented stoichiometric YBCO film matrix. Thermal critical current behavior at zero field in thin films of YBCO fabricated by various methods has been studied by three techniques: transport measurements on patterned microbridges, dc magnetization hysteresis loops using the Bean model and non-linear ac susceptibility analysis. Absolute critical current values obtained form the two former techniques when measured on the same YBCO film were observed to differ about a factor of two.

7041 (UCRL-JC–113769) **Nanoscale plasticity in silica glass.** Glosli, J.N.; Boercker, D.B.; Tesar, A.; Belak, J. Lawrence Livermore National Lab., CA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9311102–5: American Society for Precision Engineering (ASPE) conference, Seattle, WA (United States), 7-12 Nov 1993). Order Number DE94004212. Source: OSTI; NTIS; GPO Dep.

Mechanisms of nano-scale plasticity and damage initiation in silica glass is examined using molecular dynamics simulation. Computer experiments are carried out by indenting a sharp diamond-like tool, containing 4496 atoms, into a silica slab consisting of 12288 atoms. Both elastic and plastic deformation of silica is observed during nanoindentation simulation; this transition occurs at an indentation of 1.25 nm, and the calculated hardness (15GPa for 1.5 nm indentation) agrees with experiment.

3606 Other Materials

Refer also to citation(s) 6057, 6075, 6139, 6140, 6160, 6320, 6470, 6472, 6473, 6474, 6475, 6527, 6868, 6897, 6936, 6937, 6938, 6939, 6973, 6986, 7009, 7019, 7031, 7090, 7113, 7116, 7126, 7129, 7135, 7141, 7183, 7191, 7192, 7193, 7194, 7195, 7196, 7333, 7335, 7336, 7356, 7431, 7512, 7756, 7778, 7779, 7780

7042 (ANL/CHM/PP–81072) **Fullerenes as precursors for diamond film growth without hydrogen or oxygen additions.** Gruen, D.M.; Liu, S.; Krauss, A.R.; Luo, J.; Pan, X. Argonne National Lab., IL (United States). Oct 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94004582. Source: OSTI; NTIS; INIS; GPO Dep.

Diamond films are predominantly grown using one percent or so of a hydrocarbon precursor in hydrogen gas. Hydrogen is generally believed to be necessary for the diamond thin film growth process. However, hydrogen in varying amounts is inevitably incorporated in the growing diamond lattice, leading to structural defects. The

authors report here for the first time the successful growth of diamond films using fullerene precursors in an argon microwave plasma, a unique development achieved without the addition of hydrogen or oxygen. It is speculated that collisional fragmentation of C_{60} to give C_2 could be responsible for the high growth rate of the very fine grained diamond films.

7043 (ANL/ET/CP–81579) **Pull-test adhesion measurements of diamondlike carbon films on silicon carbide, silicon nitride, aluminum oxide, and zirconium oxide.** Erck, R.A. (Argonne National Lab., IL (United States)); Nichols, F.A.; Dierks, J.F. Argonne National Lab., IL (United States). Oct 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9311104–17: 40. national symposium of the American Vacuum Society (AVS), Orlando, FL (United States), 15-19 Nov 1993). Order Number DE94005469. Source: OSTI; NTIS; GPO Dep.

Hydrogenated amorphous carbon films or diamondlike carbon (DLC) films were formed by ion-beam deposition of 400 eV methane (CH_4) ions on several smooth and rough ceramics, as well as on ceramics coated with a layer of Si and Ti. Adhesion was measured by the pin-pull method. Excellent adhesion was measured for smooth SiC and Si_3N_4, but adhesion of DLC to Al_2O_3 and ZrO_2 was negligible. The use of a Si bonding interlayer produced good adhesion to all the substrates, but a Ti layer was ineffective because bonding between the DLC film and Ti was poor. The presence of surface roughness appeared to greatly increase the measured adhesion in all cases. Bulk thermodynamic calculations are not directly applicable to bonding at the interface. If the standard enthalpy of formation for reaction between CH_4 and substrate is calculated assumpting a carbide or carbon phase is produced, a relation is seen between reaction enthalpy and relative adhesion. Large positive enthalpies are associated with poor adhesion; negative or small positive enthalpies are associated with good adhesion. This relation between enthalpy and adhesion was also observed for DLC deposited on Si. Lack of adhesion to Ti was attributed to inadvertent formation of a surface oxide layer that rendered the enthalpy for reaction with CH_4 strongly positive and similar in magnitude to that for Al_2O_3 and ZrO_2.

7044 (ANL/MSD/CP–81580) **Electro-optic materials by solid source MOCVD.** Hiskes, R. (Hewlett-Packard Co., Palo Alto, CA (United States)); Dicarolis, S.A.; Fouquet, J.; Lu, Z.; Feigelson, R.S.; Route, R.K.; Leplingard, F.; Foster, C.M. Argonne National Lab., IL (United States). Dec 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931108–36: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94005120. Source: OSTI; NTIS; GPO Dep.

The solid source MOCVD technique, employing a single powder vaporization source composed of mixed beta-diketonate metalorganic compounds, has been used to grow thin films of a variety of electro-optic materials, including lithium niobate, strontium barium niobate, and potassium niobate. Preliminary results for potassium niobate films indicate that a volatile potassium organometallic source can be synthesized useful for growing potassium niobate by MOCVD. High single phase (001) oriented strontium barium niobate films have been deposited which exhibit waveguiding behavior. The most extensive work has been done on lithium niobate deposited epitaxially on a variety of substrates. Oriented z-axis (001) films have been grown on c-axis sapphire with and without a (111) oriented platinum base electrode and on a bulk grown lithium niobate substrate. Films grown directly on c-axis sapphire at 700 C exhibit x-ray rocking curve linewidths as low as .044 degrees, nearly perfect in-plane orientation as determined by x-ray phi scans, and peak-to-peak surface roughness less than 40 Å. Optical waveguiding has been demonstrated by single prism coupling technique on similar films 1175–2000 Å thick grown at 500 C, with optical losses of approximately 2 db/cm at 632.8 nm measured over 3.5 cm long films. Polarization vs. electric field measurements on 1100 Å thick films grown on platinum show a hysteresis loop indicating ferroelectric behavior.

7045 (CONF-9210121–, pp. 83-102) **Future uses of radioactive ion beams in materials science.** Haas, H. (CERN, Geneve (Switzerland)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

A short summary of the present use of radioactive beams for condensed matter research in the ISOLDE program is presented. Future uses of high intensity and high energy radioactive ion beams beyond the scope of the present projects are discussed. As examples the study of diffusion in immiscible systems by deep implantation of radiotracers, the deposition of decelerated ion beams on surfaces, the technique of beta-NMR following tilted-foil nuclear polarization and the transmutation doping of wide-bandgap semiconductors are presented. The major requirements for use of a future radioactive ion beam factory in the field of materials research are derived. Particularly important is a wide energy range from 20 keV to 500 keV/A, a frequent recurrence of a given beam and a suitable infrastructure.

7046 (CONF-930405–52) **Electron microscopy studies of undoped and phosphorus doped Si:H and Si,C:H films.** Chen, Y.L. (North Carolina State Univ., Raleigh, NC (United States)); Wang, C.; Lucovsky, G.; Maher, D.M.; Bentley, J. Oak Ridge National Lab., TN (United States); North Carolina State Univ., Raleigh, NC (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400 ; AC05-76OR00033. From Spring meeting of the Materials Research Society; San Francisco, CA (United States); 12-16 Apr 1993. Order Number DE94004738. Source: OSTI; NTIS; GPO Dep.

Microstructure of undoped and phosphorus doped Si:H and Si,C:H films was analyzed by selected-area diffraction, conical dark-field imaging, energy-dispersive x-ray spectroscopy, and electron energy-loss spectroscopy in transmission electron microscopes. Thin films were synthesized by remote plasma-enhanced chemical vapor deposition and characterized in terms of degree of crystallinity. Distribution of phosphorus in Si:H and Si,C:H films, and of carbon in Si,C:H films was evaluated. Results indicate that (i) the microstructure of a film may be two phase, consisting of silicon microcrystallites in an amorphous matrix, (ii) phosphorus doping as well as the presence of carbon influences the degree of crystallinity by reducing the average size and volume fraction of microcrystallites, (iii) the presence of carbon and phosphorus doping completely suppresses the crystalline phase, (iv) phosphorus is distributed at approximately the same concentration in both the crystalline and amorphous phases of diphasic films, and (v) carbon is detected in the amorphous phase of the Si,C:H films.

7047 (DOE/CE/23810–15) **Compatibility of refrigerants and lubricants with engineering plastics: Final report.** Cavestri, R.C. Imagination Resources, Inc., Dublin, OH (United States). Dec 1993. 167p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91CE23810. Order Number DE94004959. Source: OSTI; NTIS; GPO Dep.

23 plastics have been subjected to immersion studies using 7 different lubricants at 60 C and 100 C, and 10 different refrigerants at ambient and 60 C. In the first part of the study, 22 hermetic stress crack-creep rupture test chambers were used to determine dynamic effects of a constant dead weight load on plastic test bars immersed at 20 C in a 40% refrigerant 32 ISOVG branched acid polyolester lubricant. The creep modulus data of the 10 refrigerants, using a dead weight load of 25% of ultimate tensile, are compared to values for air and HCFC-22. In the second part, the plastic test bars were aged for 14 d at constant refrigerant pressure 300 psia with 17 refrigerant lubricant combinations at 150 C. Additional evaluations were conducted to elucidate the effects of temperature, refrigerant, and lubricant on the plastics. At 150 C, high acid formation (high TAN) was further examined with dehydrated plastics. These evaluations indicate that dehydrating the plastics reduced, but did not eliminate, high TAN values and that heat alone caused the lost physicals. Alternative HFC refrigerants had little impact on plastics; some polyolester lubricants caused identifiable changes.

7048 (DOE/CE/23810–22A) **Thermophysical properties of HFC-143a and HFC-152a: Quarterly report, 1 July 1993–30**

September 1993. Haynes, W.M. National Inst. of Standards and Technology, Boulder, CO (United States). Thermophysics Div. Oct 1993. 27p. Sponsored by USDOE, Washington, DC (United States);National Inst. of Standards and Technology, Gaithersburg, MD (United States). DOE Contract FG02-91CE23810. Order Number DE94004236. Source: OSTI; NTIS; GPO Dep.

Numerous fluids have been identified as promising alternative refrigerants, but much of the information needed to predict their behavior as pure fluids and as components in mixtures does not exist. In particular, reliable thermophysical properties data and models are needed to predict the performance of the new refrigerants in heating and cooling equipment and to design and optimize equipment to be reliable and energy efficient. Objective of this project is to provide highly accurate, selected thermophysical properties data for refrigerants HFC-143a (CH_3CF_3) and HFC-152a (CH_3CHF_2) and to use these data to fit complex equations of state and detailed transport property models. The new data will fill gaps in the existing data sets and resolve problems and uncertainties that exist in and between the data sets.

7049 (DOE/CE/23810–22B) **Solubility, viscosity and density of refrigerant/lubricant mixtures: Quarterly technical progress report, 1 July 1993–30 September 1993.** Henderson, D.R. Spauschus Associates, Inc., Stockbridge, GA (United States). Oct 1993. 65p. Sponsored by USDOE, Washington, DC (United States);National Inst. of Standards and Technology, Gaithersburg, MD (United States). DOE Contract FG02-91CE23810. Order Number DE94004237. Source: OSTI; NTIS; GPO Dep.

This report presents results of measurements on low refrigerant concentration mixtures (0, 10, 20, 30 wt %) of CFC-12, HCFC's 22, 123 and 124, HFC's 134a, 32 and 125 with mineral oil, alkylbenzene and polyolester lubricants. Viscosity, solubility (vapor pressure) and density data are reported for 23 working fluids composed of combinations of these refrigerants and companion lubricants. These data, reduced to engineering form, are presented in form of a Daniel Chart and a plot of density vs temperature and composition. Extensive numerical analysis has been performed in order to derive equations which allow two independent variables (temperature and composition) and to provide for corrections in composition due to vapor space volume in the test apparatus; details of these calculations are provided.

7050 (DOE/ER/14104–4) **Translational-energy-resolved studies of photogenerated carrier-induced reactions on UHV semiconductor surfaces.** Osgood, R.M. Jr. Columbia Univ., New York, NY (United States). [1993]. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER14104. Order Number DE94004169. Source: OSTI; NTIS; GPO Dep.

This year we have observed and understood the central phenomena of adsorbate photochemistry of semiconductor-adsorbate interfaces. In particular, it was observed that a major channel of photochemistry on a semiconductor surface is through the transfer of photoexcited substrate electrons to the adsorbed molecules. In contrast, photochemical processes by direct intra-adsorbate excitation are largely quenched for molecules in direct contact with the surface. The electron-transfer mediated process leads to both desorption and intra-adsorbate bond cleavage. The transfer may be by hot electrons or thermalized electrons in the conduction band. Dynamics of the electron-transfer reaction vary greatly for molecules in the first and second layer and for molecules of different orientations in the first layer. While molecules in the second layer can be dissociated only through the transfer of hot electrons or direct photon bond cleavage, those in the first layer react by thermalized electrons as well as hot electrons, depending on the orientation of the molecules. The two processes are differentiated experimentally by the different characteristic energy and angular distribution of the photofragments. In addition, we have discovered that reaction self-quenching can be an important process in thermalized electron-induced reactions on semiconductor surfaces. This behavior stems from effects on lifetime of the thermalized carriers by reaction products left on the surface. Finally, importance of electron-transfer-induced reactions at surfaces arises in part from shift in lowering of unoccupied electronic orbitals of adsorbates in image region of semiconductor surfaces. This latter effect is also largely responsible for a red shift observed for photochemical processes on surfaces.

7051 (DOE/ER/61403–2) **Hydrodynamic controls on particle transport through heterogeneous porous media: Technical progress report.** Silliman, S.E.; Babic, M. Notre Dame Univ., IN (United States). Dept. of Civil Engineering and Geological Sciences. 28 Sep 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER61403. Order Number DE94000963. Source: OSTI; NTIS; GPO Dep.

Sophisticated models of the movement of particles, particularly bacteria and viruses, through porous media have been developed, but have met with limited success when compared to field observations some argue that the poor predictive capabilities of the models are due in part to the fact that most of the sophisticated models are tied to an assumptions of homogeneity within the flow field. In previous work, the structure of random percolation fields has been investigated and suggests application of percolation theory to heterogeneous porous media. One conclusion from this study as applied to particle transport is that as the distribution of pore throat sizes takes on variation in the third dimension, the probability of finding a continuous flow path with large throat size increases. One interpretation of this work, within the current context, leads to an argument that a saturated medium will become more open to transport of particles as the medium takes on three dimensional structure. The central hypothesis of the current project is therefore be stated: Particles which are suspended within the pore fluids of media demonstrating three-dimensional heterogeneities will be transported at higher average velocities and with less trapping than particles which are suspended in the pore fluids of media demonstrating one- or two-dimensional heterogeneities. This dependence on dimension is a function of the dimensional character of the heterogeneity, the length scales of the heterogeneity, the size of the particles, the hydrodynamics of the flow field, the degree of saturation of the medium, and the medium/particle interaction.

7052 (DOE/FTR–93018764) **Travel to Hungary, Poland, and Germany for investigation of research and materials in photovoltaic activities: Foreign trip report, May 4–20, 1991.** Ciszek, T. Solar Energy Research Inst., Golden, CO (United States). 7 Jun 1991. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-83CH10093. Order Number DE93018764. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Silicon is the dominant material in photovoltaic research and development activities in Germany. In PV silicon material activities, the trend is toward higher quality (i.e. higher solar cell efficiency) material, driven by balance of system cost considerations. There are not many PV materials research activities in the Eastern European countries, particularly in the current economic climate. However, there are many interesting crystal growth activities in various oxide and semiconductor materials.

7053 (DOE/FTR–93019276) **Travel to Granada, Spain for discussions on materials that exhibit complex relaxations: Foreign trip report, June 21–17, 1993.** Martin, J.E. Sandia National Labs., Albuquerque, NM (United States). 17 Aug 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93019276. Source: OSTI; NTIS (US Sales Only); GPO Dep.

First week of this trip was spent at the Applied Physics Department at the University of Granada, where faculty Profs. Roque Hidalgo-Alvarez and Miguel Cabrerizo-Vilchez discussed experimental studies on irreversible aggregation of colloidalparticles suspended on surfaces and bulk phase. The surface studies used optical imaging to determine the time evolution of flocculation, whereas the experiments on bulk solutions used SPOS-Single Particle Optical Scattering for time evolution of flocculation. These experimental studies are closely aligned with experimental work conducted in my own laboratory. On June 24 1 presented a long lecture at the University of Granada on the use of fractal concepts in materials science, including applications to polymeric and colloidal systems. On June 28 1 traveled to Alicante to attend the 2nd International Discussion Meeting on Relaxations in Complex Systems. I coauthored a paper entitled Light Scattering Investigation of Phase Separation in Micellar Systems and presented a paper entitled Light Scattering Studies of the Electrorheological Transition.

7054 (IC–93/266) **Glass transition temperature and molar volume versus average coordination number in Ge_{100-x} S_x bulk glasses.** Saffarini, G. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 9p. Order Number DE94610398. Source: OSTI; NTIS (US Sales Only); INIS.

Glass transition temperatures (T_g) and molar volumes (V), of 13 glassy compositions of the $Ge_{100-x}S_x$ system, were determined using differential scanning calorimetry (DSC) and the measured values of densities, respectively. The variation of T_g and V with the average coordination number, m, are examined in light of the models proposed for the structure of these covalently bonded solids. (author). 32 refs, 2 figs, 1 tab.

7055 (INIS-mf–13742) **New materials in defence.** Khan, Sikandar S.; Khan, Shahid A.; Butt, N.M. Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). 1992. 31p. (CONF-9204276–: Seminar on research and development in support of technology with military applications, Karachi (Pakistan), 29 Apr 1992). Order Number DE94610393. Source: OSTI; NTIS (US Sales Only); INIS.

National defence is very important and always needs new such materials which have technological and socio-economic development of human society. The types of materials used by a society reflect its level of sophistication. These modern materials are basically the same conventional materials but with a greater knowledge content which include superalloys, modern polymers, engineering ceramics and the advanced composite. The production and use of new materials is playing and important role in the recent development in the defence industry. (A.B.).

7056 (IS-T–1669) **Characterization of Zns-GaP Naon-composites.** Todd, V. Ames Lab., IA (United States). 9 Dec 1993. 72p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94004888. Source: OSTI; NTIS; GPO Dep.

It proved possible to produce consistent, high-quality nanocrystalline ZnS powders with grain sizes as small as 8 nm. These powders are nano-porous and are readily impregnated with GaP precursor, although inconsistently. Both crystal structure and small grain size of the ZnS can be maintained through the use of GaP. Heat treatment of the impregnated powders results in a ZnS-GaP composite structure where the grain sizes of the phases are on the order of 10–20 nm. Conventional powder processing should be able to produce optically dense ceramic compacts with improved mechanical properties and suitable IR transmission.

7057 (LA–12684-MS) **SESAME equation of state number 8020: Polyetheretherketone (PEEK).** Boettger, J.C.; Johnson, J.D. Los Alamos National Lab., NM (United States). Dec 1993. 14p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94004191. Source: OSTI; NTIS; GPO Dep.

A new SESAME equation of state (EOS) for the polymer polyetheretherketone (PEEK) has been generated using the computer program GRIZZLY. This new EOS has been added to the SESAME EOS library as material number 8020. A few general guidelines for estimating the thermodynamic parameters for polymers needed to generate an EOS with GRIZZLY are suggested.

7058 (LA-UR–93-3967) **Stabilization of polyaniline solutions.** Wrobleski, D.A.; Benicewicz, B.C. Los Alamos National Lab., NM (United States). [1993]. 3p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940301–2: 207. spring national meeting of the American Chemical Society, San Diego, CA (United States), 13-18 Mar 1994). Order Number DE94003958. Source: OSTI; NTIS; GPO Dep.

Adding hindered amine light stabilizers (HALS) to N-methylpyrrolidinone (NMP) solutions of polyaniline delays gelation. It is hypothesized that HALS act in some manner other than as traditional antioxidants in preventing gelation; the secondary amine functional group appears to play a critical role, perhaps by disrupting the physical crystallization network that may contribute to gelation. Pyrrolidine, a secondary amine, or ammonia is an effective cosolvent with NMP in dissolving PAn-EB (emeraldine base). 6 refs, 4 figs.

7059 (LA-UR–93-4274) **Characterization of structure and mechanical properties of $MoSi_2$-SiC nanolayer composites.** Kung, H. (Los Alamos National Lab., NM (United States)); Jervis, T.R.; Nastasi, M.; Mitchell, T.E.; Hirvonen, J.P. Los Alamos National Lab., NM (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931108–33: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004982. Source: OSTI; NTIS; GPO Dep.

A systematic study of structure-mechanical properties relation is reported for $MoSi_2$-SiC nanolayer composites. Alternating layers of $MoSi_2$ and SiC were synthesized by DC magnetron and rf-diode sputtering, respectively. Cross-sectional transmission electron microscopy was used to examine three distinct reactions in the specimens when exposed to different annealing conditions: Crystallization and phase transformation of $MoSi_2$, crystallization of SiC, and spheroidization of the layer structures. Nanoindentation was employed to characterize the mechanical response as a function of structural changes. As-sputtered material exhibits amorphous structures in both types of layers and has a hardness of 11 GPa and a modulus of 217GPa. Subsequent heat treatment induces crystallization of $MoSi_2$ to form the C40 structure at 500C and SiC to form the a structure at 700C. The crystallization process is directly responsible for hardness and modulus increase in multilayers. A hardness of 24GPa and a modulus of 340GPa can be achieved through crystallizing both $MoSi_2$ and SiC layers. Annealing at 900C for 2h causes the transformation of $MoSi_2$ into the $C11_b$ structure, as well as spheroidization of the layering to form a nanocrystaulline equiaxed microstructure. A slight degradation in hardness but not in modulus is observed accompanying the layer break-down.

7060 (LA-UR–93-4343) **Microwave assisted chemical vapor infiltration.** Devlin, D.J. Los Alamos National Lab., NM (United States). [1993]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005005. Source: OSTI; NTIS; GPO Dep.

The purpose of this program is to develop a new process for the fabrication of ceramic matrix composites by chemical vapor infiltration. This period has been devoted in part to the exploration of material systems suitable for MACVI processing. A number of potential processing schemes are possible using combinations of absorbing and transparent material as composite components. This includes the use of an absorbing preform (nicalon fiber) combined with a transparent matrix (silicon nitride). Composites 5 cm in diameter by 1 cm. thick have been fabricated to densities of 65% theoretical. Processing times for these materials are under 20 hours. Higher densities will require additional microwave power now possible with the new reactor. The most effective MACVI scheme will involve the use of a transparent fiber with an absorbing matrix. The hot spot will be initiated by appropriate treatment of the central region of the preform. To this end alumna fibers with pretreatments to control thermal gradients has been explored. Nextel 610 fibers have been effectively pretreated carbon coating resulting in preferential heating in the interior of the preform. Possible matrix materials include siliconized silicon carbide, doped silicon carbide, alumna and zirconia. A patent for MACVI has been issued 10/19/93.

7061 (LBL–34763) **Se EXAFS study of the elevated wurtzite to rock salt structural phase transition in CdSe nanocrystals.** Tolbert, S.H. (Lawrence Berkeley Lab., CA (United States)); Alivisatos, A.P. Lawrence Berkeley Lab., CA (United States). Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States);Sloan (Alfred P.) Foundation, New York, NY (United States);American Chemical Society, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9306223–2: North Atlantic Treaty Organization (NATO) advanced study meeting of Institute on Nanophas Materials, Corfu (Greece), 20 Jun - 2 jul 1993). Order Number DE94003247. Source: OSTI; NTIS; GPO Dep.

High pressure Se EXAFS data has been obtained on 2.7 nm radius CdSe semiconductor nanocrystals. This system is observed to

undergo a solid-solid phase transition at 6.5 GPa which is approximately twice the reported value for bulk CdSe. In combination with high pressure optical absorption experiments, EXAFS data can be used to identify the high-pressure phase structure as rock salt. EXAFS data can be fit with equations of state to yield pressure volume curves. Resultant values of bulk modulus and its derivative with respect to pressure are $B_o = 37 \pm 5$ GPa and $B_o' = 11 \pm 3$. A thermodynamic model for the data is presented in which the internal energy in each phase is modified by a surface energy term. Differences in surface energy are used to explain the elevation in phase transition pressure. The model can be used to estimate a value for the surface energy in the rock salt phase; 1.9 ± 0.3 N/m is obtained in comparison to 0.9 ± 0.1 N/m for the wurtzite phase.

7062 (LBL–34875) **Pore-size distributions of N-isopropylacrylamide (NIPA) hydrogels.** Walther, D.H. (Univ. of California, Berkeley, CA (United States). Dept. of Chemical Engineering); Blanch, H.W.; Prausnitz, J.M. Lawrence Berkeley Lab., CA (United States). Nov 1993. 23p. Sponsored by USDOE, Washington, DC (United States);National Insts. of Health, Bethesda, MD (United States). DOE Contract AC03-76SF00098. Grant R01 GM46788-01. Order Number DE94004939. Source: OSTI; NTIS; GPO Dep.

Pore-size distributions have been measured for N-isopropylacrylamide (NIPA) hydrogels at 25 and 32°C with swelling capacities 11.3 and 6.0 g swollen gel per g dry gel. The mixed-solute-exclusion method (introduced by Kuga) was used to obtain the experimental solute-exclusion curve which represents the amount of imbibed liquid inside the gel inaccessible for a solute of radius r. The pore-size distributions were obtained by using Casassa's Brownian-motion model and numerically solving the Fredholm integral equation. The pore-size distributions of temperature-sensitive NIPA hydrogels are strongly dependent on temperature which determines swelling capacity. With increasing swelling capacity (from 6.0 to 11.3), the pore-size distribution shifts to higher mode values (27.3 to 50.6 Å) and to higher variance ($1.07 \cdot 10^3$ to $3.58 \cdot 10^3$ Å^2).

7063 (NCRD–1-93, pp. 97) **On the nature of oxygen bonding in BiSrCaCuO superconductors as reflected through Auger parameters and O(KLL) intensities.** Alezra, D. (Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Nuclear Engineering); Baram, J.; Polak, M. Ministry of Science and Technology, Jerusalem (Israel). Jan 1993. 221p. Sponsored by Israel Electricity Co., Tel Aviv (Israel);Ministry of Science and Technology, Jerusalem (Israel). (CONF-9301133–: 2. international Israeli conference on High Tc Superconductivity, Eilat (Israel), 4-7 Jan 1993). In *Second international Israeli conference on High Tc Superconductivity: Scientific program and abstracts.* Order Number DE94608732. Source: OSTI; NTIS (US Sales Only); INIS.

Short communication. HIGH-TC SUPERCONDUCTORS/energy-level transitions; AUGER EFFECT; CUPRATES

7064 (NRCN(TN)–146) **Design and construction of an experimental HIP system comprising in-situ ultrasonic sound wave velocity measurements.** Tamsut, S.; Feuerlicht, Y.; Ganor, M.; Kalir, D.; Yeheskel, O. Israel Atomic Energy Commission, Beersheba (Israel). Nuclear Research Center-Negev. Apr 1993. 26p. (In Hebrew). Order Number DE94610395. Source: OSTI; NTIS (US Sales Only); INIS.

Hot Isostatic Pressing (HIP) is a process used to manufacture engineering components from metallic and ceramic powders, to diffusion-bond materials and to heal defects in castings. Powder densification is performed by encapsulating the powder in a sealed container and applying isostatic pressure at it. The collapsing of the can plastically deforms the powder particles and when temperature is raised, creep and diffusion mechanisms become active. The sintering processes, provided that sufficient time is allowed, lead to a fully dense and pore-free material. In many cases, a material made from powder by HIP, has mechanical properties superior to those manufactured using other methods. The properties of a material produced by HIP is a function of the process parameters - temperature, pressure and time. until quite recently those parameters were set through numerous HIP cycles accompanied by testing the end products to determine their properties. Metallurgical and economical reasons encourage researchers to propose ways for the in-situ monitoring of the processes taking place in the specimen as it is being HIP'ed. Several techniques including the Ashby model or inserting a dilatometer or an eddy current transducer into the pressure vessel are under consideration. A unique system developed at NRCN aimed at the in-situ monitoring of sintering processes is presented. It is based on the continuous measurement of sound wave velocity in the HIP'ed material. The construction of a HIP comprising ultrasonic sound waves velocity measurement facility is described. Some results of experiments in which the relationship between sound velocity and the material's quality are given. (authors).

7065 (NREL/CP–200-5768-Vol.2, pp. 1332-1338) **Hemicellulose as a potential substrate for production of PHA (a biodegradable thermoplas).** Ramsay, J.A. (Polyferm Inc., Dollard-des-Ormeaux, Quebec (Canada)); Aly Hassan, M.C.B.; Ramsay, B.A. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Although hemicellulose has been proposed as a fermentation feedstock for ethanol, butanediol, acetone and butanol production, little is known about making poly-β-hydroxyalkanoates (PHAs) from it. PHAs are a family of microbially-produced, β-hydroxycarboxylic acid polyesters which have thermoplastic properties and biodegrade completely to CO_2 and H_2O. Its commercialization is limited by high production cost which in part is due to substrate cost. Pseudomonas cepacia accumulated up to 60% of its dry weight biomass as PHA when grown in nitrogen-limited medium containing xylose as the sole carbon source. The culture performed well on xylanase-treated hemicellulose obtained from steam exploded trembling aspen (Tigney Technology Inc., Alberta). The specific growth and specific PHA production rates of P. cepacia were lower when grown on xylose than on fructose. While the yield of PHA (g PHA per g substrate consumed) was also lower on xylose than on glucose, the culture has the potential to accumulate the same amount of PHA per cell on both substrates.

7066 (NREL/CP–200-5768-Vol.2, pp. 1339-1343) **New lignin products for ecological situation improvement.** Telysheva, G. (State Institute of Wood Chemistry, Riga (Latvia)); Shulga, G. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Ecologically safe lignin-derived polymers with adhesion and structure-forming properties were synthesized by chemical modification of water soluble lignins with heterocyclic polymeric or oligomeric reagents. The affinity of lignin products to inorganic particles is regulated by the variation of synthesis conditions (mass ratio of the reagents, pH, temperature, etc.) and the choice of modifier. High adhesive characteristics of the synthesized products, after application of their water solution on coal ash surfaces, prevent erosion and considerably improve the ecology in the neighborhood of thermal power stations. Formed ash-polymer coatings are composite materials with a three-dimensional polymer matrix that encapsulates the ash particles. Such coatings show high mechanical and water resistance, good water penetration, and wind stability (more than 30 m/s). The chemical transformations of lignins and lignin products under the action of UV radiation are caused by the peculiarities of their structure and chemical composition. The high photoresistance of lignin products is determined by both the formation of new covalent bonds between the lignin and modifier and of chelate complexes with metals in the ash.

7067 (NREL/CP–200-5768-Vol.2, pp. 1344-1366) **Commercialization of low molecular weight guayule rubber in environmentally friendly coatings.** Thames, S.F. (Univ. of Southern Mississippi, Hattiesburg, MS (United States)); He, Z.A. National Renewable Energy Lab., Golden, CO (United States). [1993].

(CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

Guayule (Parthenium Argentatum Gray), a shrub growing in the southwest United States and Mexico, is a promising domestic source of natural rubber. Low molecular weight guayule rubber (LMWGR) is one of four major coproducts obtained during the processing of the guayule shrub and this work describes our recent efforts directed to the derivation of value-added LMWGR derivatives; in particular chlorinated hydroxylated LMWGR and acrylated chlorinated LMWGR. Both products are useful as raw materials for the formulation of low volatile organic compound (VOC) coating formulations. Chlorinated hydroxylated LMWGR was synthesized via the chlorination of partially hydroxylated LMWGR whose structure was confirmed by ^{1}H and ^{13}C NMR spectroscopy, elemental analysis, and fourier transform infrared spectroscopy (FTIR). We have used chlorinated hydroxylated LMWGR as a reactive, primary alcohol in high solids polyurethane tough, of high gloss, and resistant to water, selected solvents, acids, and bases. Acrylated chlorinated low molecular weight rubber (ACLMWGR) was synthesized via reacting chlorinated hydroxylated LMWGR and acryloyl chloride. ACLMWGR is a useful prepolymer in 100% solids, UV cure coating formulations. The coatings cure readily when exposed to ultraviolet light giving films with excellent adhesion, good chemical resistance, ease of sanding, and water and solvent resistance. The cured finishes are hard, attractive, of high gloss, and possess excellent adhesion as well as superb water and solvent resistance.

7068 (NUTEK–89-3419) **Grindability of alumina fibre reinforced aluminium-alloy matrix composite material.** Chandrasekaran, H.; Johansson, J.O. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden); Swedish Inst. for Metals Research, Stockholm (Sweden). Dec 1992. 65p. (IM–2928). Order Number DE94730438. Source: OSTI; NTIS.

This report describes for the first time the grindability behaviour of Al-2Mg and Al-9Si-3Cu alloy based MMC composites reinforced with varying amounts of short alumna fibres in terms of material removal mechanisms and surface features of ground specimens rather than the traditional wheel wear studies. Conventional and super abrasive grinding wheels (Al203, SiC with vitrified bond, cubic BN and synthetic diamond with organic bond) were used. No optimisation of the grinding operation was intended and tests were carried out for a range of grinding parameters. Grinding forces and surface finish were measured, and the surfaces investigated using optical and scanning electron microscopy. The grinding conditions appear to play little role upon the measured surface finish. The abrasive type on the other hand have controlling influence although this was not readily indicated by the conventional surface finish parameters. SEM studies however, revealed diamond grinding to be the best followed by CBN grinding on the basis of the quality of the surface obtained. Both Al2O3 and SiC displayed insufficient hardness and sharpness, in addition to severe wheel loading from adhesion. Diamond grinding also displayed minimal forces, temperature rise (theoretical estimation) and low friction due to the associated clean decapitation of the hard fibres. The severe disturbance of the near surface fibres with increasing severity from the case of diamond to Al2O3 grinding, and the development of microcavities corresponding to the contour of the fibres in the grinding plane, detected during the present studies are critical factors to be considered in demanding applications. 16 refs, 39 figs, 7 tabs

7069 (ORNL/SUB–88-SC423/01) **Investigation of forced and isothermal chemical vapor infiltrated SiC/SiC ceramic matrix composites: Final report.** Sankar, J. (North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Mechanical Engineering); Kelkar, A.D.; Vaidyanathan, R. North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Mechanical Engineering; Oak Ridge National Lab., TN (United States). Sep 1993. 216p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004544. Source: OSTI; NTIS; GPO Dep.

Mechanical properties of two different layups for each of the forced CVI (41 specimens) and isothermal CVI (36 specimens) materials were investigated in air at room temperature (RT), 1000C, and at room temperature after thermal shock (RT/TS) and exposure to oxidation (RT/OX). The FCVI specimens had a nominal interfacial coating thickness of 0.3 μm of pyrolytic carbon, while CVI specimens had a coating thickness of 0.1 μm. Effect of reinforcement and interfacial bond on mechanical properties of composite were investigated. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) were employed to analyze the fiber-matrix interface and the toughening mechanisms in this ceramic composite system.

7070 (PNL-SA–22525) **Effect of temperature and recoil-energy spectra on irradiation-induced amorphization in $Ca_2La_8(SiO_4)_6O_2$.** Weber, W.J. (Pacific Northwest Lab., Richland, WA (United States)); Wang, L.M. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9309259–2: Nuclear instruments and methods in physics research on radiation effects in insulators, Nagoya (Japan), Sep 1993). Order Number DE94004371. Source: OSTI; NTIS; INIS; GPO Dep.

Single crystals of $Ca_2La_8(SiO_4)_6O_2$ have been irradiated with different ions/energies in an in situ study of the effects of temperature and recoil-energy spectra on irradiation-induced amorphization. The dose for complete amorphization increases with temperature in two stages. The low-temperature stage (below 250 K) has an activation energy of 0.01 $\pm$ 0.003 eV and is believed to be associated with simultaneous close-pair recombination. The high-temperature stage (above 250 K) has an activation energy of 0.13 $\pm$ 0.02 eV and may be associated with irradiation-enhanced defect mobility. The critical temperature for amorphization increases from ~360 K for 0.8 MeV Ne^+ to ~710 K for 1.5 MeV Kr^+. At 15 K, the amorphization dose is ~0.36 dpa and is independent of recoil-energy spectra. The amorphization dose increases more rapidly with temperature for Ne^+ due to the larger fraction of mobile defects produced by the low energy recoils. The temperature dependence is similar for 1.0 MeV Ar^+, 1.5 MeV Kr^+, and 1.5 MeV Xe^+.

7071 (PNL-SA–22561) **Structure and properties of intermetallic composites synthesized in situ using solid state displacement reactions.** Henager, C.H. Jr. (Pacific Northwest Lab., Richland, WA (United States)); Brimhall, J.L.; Hirth, J.P. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 29p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930997–7: 1. international symposium on structural intermetallics, Champion, PA (United States), 26-30 Sep 1993). Order Number DE94004312. Source: OSTI; NTIS; GPO Dep.

Solid state displacement reactions can produce in situ intermetallic matrix composites in a process where an intermetallic phase(s) and a potential reinforcing phase(s) are grown together during a solid state reaction. Interwoven and dispersed microstructures, important for desirable composite properties, have been produced by means of displacement reaction processing techniques. Two such composites have been synthesized: $MoSi_2$ reinforced with SiC particles, and $NiAl/Ni_3Al$ reinforced with Al_2O_3. Strength in bending and chevron-notch fracture toughness have been determined as a function of temperature and measured properties compare favorably with composites produced by other means. The measured properties are discussed with regard to the observed microstructures. The potential for displacement reaction processing is assessed and appears to be a cost-effective synthesis method compared to others.

7072 (SAND–93-0574C) **Ion implantation in silicate glasses.** Arnold, G.W. Sandia National Labs., Albuquerque, NM (United States). [1993]. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931168–2: 3. Pacific Rim forum on composite materials: low-cost high-volume composite materials, Honolulu, HI (United States), 7-10 Nov 1993). Order Number DE94003785. Source: OSTI; NTIS; GPO Dep.

This review examines the effects of ion implantation on the physical properties of silicate glasses, the compositional modifications that can be brought about, and the use of metal implants to form colloidal nanosize particles for increasing the nonlinear refractive index.

7073 (SAND–93-0579C) **Transient radiation-induced absorption in laser materials.** Brannon, P.J. Sandia National Labs., Albuquerque, NM (United States). [1994]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940142–1: OE/LASE '94: conference on optics, electro-optics, and laser applications in science and engineering, Los Angeles, CA (United States), 22-29 Jan 1994). Order Number DE94003773. Source: OSTI; NTIS; GPO Dep.

Transient radiation-induced absorption losses in laser materials have been measured using a pulsed nuclear reactor. Reactor pulse widths of 70 to 90 μs and absorbed doses of 1 to 7.5 krad have been used. Transmission recovery times and peak absorption coefficients are given. Materials tested include $LiNbO_3$, GSGG, silica substrates, and filter glasses used in the laser cavity. The filter glasses are tested at discrete wavelengths in the range 440–750 nm. Lithium niobate , MgO doped $LiNbO_3$, GSGG, and the silica substrates are tested at 1061 nm.

7074 (SAND–93-1453C) **Binding of copper and nickel to cavities in silicon formed by helium ion implantation.** Myers, S.M.; Follstaedt, D.M.; Bishop, D.M. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931108–7: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94003769. Source: OSTI; NTIS; INIS; GPO Dep.

Cavities formed in Si by He ion implantation and annealing are shown to be strong traps for Cu and Ni impurities. Experiments utilizing ion-beam analysis and transmission electron microscopy indicate that Cu is trapped at the internal surfaces of cavities up to ~1 monolayer coverage with a binding energy of 2.2±0.2 eV relative to solution. This is greater than the heat of solution from the precipitated Cu_3Si phase, determined to be 1.7 eV in agreement with earlier work. Copper at cavity-wall sites is reversibly replaced by H during heating in H_2 gas, indicating the relative stability of the two surface terminations. Initial results for Ni impurities indicate that trapping at cavities is again energetically preferred to silicide formation. The saturation coverage of Ni on the internal surfaces, however, is an order of magnitude smaller for Ni than Cu, consistent with published studies of external-surface adsorption. These results suggest that cavity trapping may getter metallic impurities in Si more effectively than methods based on silicide precipitation.

7075 (SAND–93-1471C) **Microstructures of Si surface layers implanted with Cu.** Follstaedt, D.M.; Myers, S.M. Sandia National Labs., Albuquerque, NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931108–26: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004690. Source: OSTI; NTIS; GPO Dep.

Microstructures of Si ion-implanted with Cu have been characterized by TEM after annealing. For 1.2 at.%, the Cu is trapped at planar defects, but for 10 at.%, η-Cu_3Si forms and Cu diffuses at its equilibrium solubility. These observations allow proper evaluation of the binding energies of Cu to previously formed internal cavities (2.2 eV) and η-Cu_3Si (1.7 eV). The 10 at.% Cu layer promotes oxidation of Si catalyzed by η-Cu_3Si. The microstructures also indicate that Si implanted with ~2 at.% Cu reforms epitaxially with embedded defects after 8 hr at 700C, but for ~10 at.% Cu, epitaxy is not recovered after 6 hours at 600C.

7076 (SAND–93-1493C) **Ordering and phase separation in MOCVD InGaP alloys and unicompositional quantum wells.** Follstaedt, D.M.; Schneider, R.P. Jr.; Jones, E.D. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931108–24: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004693. Source: OSTI; NTIS; GPO Dep.

The microstructures of $In_{0.5}Ga_{0.5}P$ alloys grown on (100) GaAs by MOVPE have been characterized with cross-section TEM and their optical emission examined with photoluminescence at low temperatures. All the alloys exhibit spinodal-like decomposition with compositional modulations along directions in the growth plane. Alloys grown at 775C have the highest emission energy, 2.0 eV, while those at 675C have the lowest, 1.89 eV, due to strong CuPt-type ordering of In and Ga. The ordered domains are platelets 20 to 200 nm wide and 10–20 nm thick with antiphase boundaries 1–2 nm apart. We have also formed "unicompositional" quantum wells of thin (1.3–20 nm) ordered layers grown at 675C between disordered barriers grown at 775C. Ordering is found only in the active layer, with domains similar to those of thick layers. The emission energy increases by 90 meV as the well thickness is decreased from 10 to 1.3 nm, thus demonstrating quantum size effects solely through disorder-order phenomena.

7077 (SAND–93-1529C) **Electric-field dependence of electroreflectance and photocurrent spectra at visible wavelengths in MOVPE-grown InAlGaP multiple strained quantum-well structures.** Fritz, I.J.; Blum, O.; Schneider, R.P. Jr.; Howard, A.J.; Follstaedt, D.M. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931108–20: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004692. Source: OSTI; NTIS; GPO Dep.

The authors present electric-field dependent electroreflectance and photocurrent spectra of visible-bandgap $In_x(Al_yGa_{1-y})_{1-x}P/In_{x'}(Al_{y'}Ga_{1-y'})_{1-x'}P$ multiple-quantum-well (MQW) structures. These structures, grown by metal-organic vapor phase epitaxy on 6°-misoriented (100) GaAs substrates, have undoped MQWs sandwiched between doped $In_{0.5}Al_{0.5}P$ layers, forming p-i-n diodes. Quantum-well compositions in the range $0.46 \leq x \leq 0.52$ and $0 \leq y \leq 0.4$, corresponding to bandgaps in the red to yellow-green range, were used. The Stark shifts in these various samples were measured and found to depend on the details of the Mg p-type doping profile, confirming important diffusion effects, in agreement with secondary ion mass spectrometry and capacitance-voltage data. The results show that these new materials are promising for visible-wavelength optical modulator applications.

7078 (SAND–93-2417) **Transient radiation-induced absorption in the materials for a GSGG laser.** Brannon, P.J. Sandia National Labs., Albuquerque, NM (United States). Nov 1993. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94005316. Source: OSTI; NTIS; INIS; GPO Dep.

Materials used in the optical elements of a 1,061 m GSGG (gadolinium scandium gallium garnet) laser have been tested for transient radiation-induced absorption. The transient radiation-induced absorption in KK1, Schott S7005 and S7010, and M382 glasses have been determined for discrete wavelengths in the range 440–750 nm. Also, the transient radiation-induced absorption in "pure" and MgO doped $LiNbO_3$ has been measured at 1,061 nm. Mathematical expressions composed of exponentials are fitted to the data.

7079 (SAND–93-2542C) **Sol-gel derived silica/siloxane composite materials: The effect of loading level and catalyst activity on silica domain formation.** Black, E.P. (Sandia National Labs., Albuquerque, NM (United States)); Ulibarri, T.A.; Beaucage, G.; Schaefer, D.W.; Assink, R.A.; Bergstrom, D.F.; Giwa-Agbomeirele, P.A.; Burns, G.T. Sandia National Labs., Albuquerque, NM (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940301–1: 207. spring national meeting of the American Chemical Society, San Diego, CA (United States), 13-18 Mar 1994). Order Number DE94002734. Source: OSTI; NTIS; GPO Dep.

Currently, the production of in situ reinforcement in polymeric systems by sol-gel methods is undergoing rapid development. However, understanding of synthesis/structure/property relationships is still lacking. In order to produce sol-gel derived composite

materials with sufficient mechanical properties for commercial applications, this deficit of information must be addressed. We have completed a detailed investigation of in situ silica growth in polydimethylsiloxane (PDMS)/tetraethylorthosilicate (TEOS) systems. Factors which affect the domain growth, such as catalyst activity and silica loading, have been examined by solid state ^{29}Si NMR, SEM, mechanical testing and small angle neutron scattering.

7080 (SAND–93-2678C) **Molecular beam mass spectrometry studies of the chemical vapor deposition of diamond.** Hsu, Wen L. (Sandia National Labs., Livermore, CA (United States)); McMaster, M.C.; Coltrin, M.E.; Dandy, D.S. Sandia National Labs., Livermore, CA (United States). [1993]. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9311142–1: 15. dry processing symposium, Tokyo (Japan), 1-2 Nov 1993). Order Number DE94003802. Source: OSTI; NTIS; GPO Dep.

We have developed a novel molecular beam mass spectrometry technique that can quantitatively analyze the gas-phase composition in a CVD reactor. The technique simultaneously monitors a wide variety of radical and stable species, and their concentrations can be determined with sensitivities approaching 1 ppM. Measurements performed in a diamond deposition system have given us keen insights into the important phenomena that affect the growth environment. This paper first discusses the primary gas sampling design issues. In the second part, the details of the experimental results and their implications will be described.

7081 (SAND–93-2682C) **Synthesis and characterization of novel spiro penta- and hexacoordinate anionic polysiliconate and polygermylate ionomers derived from the condensation of (±) 5,5′, 6,6′ - Tetrahydroxy-1,1′ - spiro-bis(Indane) with trialkoxysilanes, tetraalkoxysilanes, and trialkoxygermanes.** Small, J.H. (California Univ., Irvine, CA (United States). Dept. of Chemistry); Shea, K.J.; Loy, D.A.; Jamison, G.M. Sandia National Labs., Albuquerque, NM (United States). [1993]. 3p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940301–4: 207. spring national meeting of the American Chemical Society, San Diego, CA (United States), 13-18 Mar 1994). Order Number DE94003722. Source: OSTI; NTIS; GPO Dep.

Synthesis of hybrid organic-inorganic materials with ionic functionality within the polymer backbone has been achieved. A new family of hypervalent spiro anionic polysiliconates and polygermylates has been prepared. These materials were shown to be thermally stable to moderate temperatures and are completely air and moisture stable. Analysis by solution and solid state NMR verified the presence of the hypervalent functionality. We are currently examining the effect that alteration of the condensing reagent and/or the counterion may have on bulk properties of the ionomeric material.

7082 (SAND–93-3825C) **Colloid formation in copper-implanted fused silica and silicate glasses.** Mazzoldi, P. (Padua Univ., (Italy). Ist. di Fisica); Caccavale, F.; Cattaruzza, E. Sandia National Labs., Albuquerque, NM (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9309259–4: Nuclear instruments and methods in physics research on radiation effects in insulators, Nagoya (Japan), Sep 1993). Order Number DE94004672. Source: OSTI; NTIS; GPO Dep.

Copper implantations (90 keV, 5×10^{16} ions/cm^2) were made into fused silica, borosilicate glasses and soda-lime glass. The copper distribution has been found to vary according to glass type. The optical absorption band characteristic of the implanted metal optical properties was observed only for copper-implanted fused silica. Absorption for all the other samples was either not observable or was negligibly small, however very small metallic particles are present also in soda-lime glass. Subsequent nitrogen implantation (100 keV, 1.5×10^{17} ions/cm^2) completely eliminated the copper-colloid induced absorption in the copper-implanted fused silica, while it facilitated formation of copper-colloids in soda-lime glass.

7083 (SAND–93-3826C) **Peculiarities and application perspectives of metal-ion implants in glasses.** Mazzoldi, P. (Padua Univ. (Italy). Dipt. di Fisica); Gonella, F.; Arnold, G.W.; Battaglin, G.; Bertoncello, R. Sandia National Labs., Albuquerque, NM (United States). [1993]. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9309259–3: Nuclear instruments and methods in physics research on radiation effects in insulators, Nagoya (Japan), Sep 1993). Order Number DE94004671. Source: OSTI; NTIS; GPO Dep.

Ion implantation in insulators causes modifications in the refractive-index as a result of radiation damage, phase separation, or compound formation. As a consequence, light waveguides may be formed with interesting applications in the field of optoelectronics. Recently implantation of metals ions (e.g. silver, copper, gold, lead,...) showed the possibility of small radii colloidal particles formation, in a thin surface layer of the glass substrate. These particles exhibit an electron plasmon resonance which depends on the optical constants of the implanted metal and on the refractive-index of the glass host. The non-linear optical properties of such colloids, in particular the enhancement of optical Kerr susceptibility, suggest that the, ion implantation technique may play an important role for the production of all-optical switching devices. In this paper an analysis of the state-of-the-art of the research in this field will be presented in the framework of ion implantation in glass physics and chemistry.

7084 (UCRL-JC–114725) **Numerical simulations of interfacial debonding in ductile-phase reinforced intermetallic matrix composites.** Henshall, G.A.; Zywicz, E.; Strum, M.J. Lawrence Livermore National Lab., CA (United States). 10 Aug 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-931078–2: Mechanism and mechanics of composite fracture meeting, Pittsburgh, PA (United States), 17-21 Oct 1993). Order Number DE94003639. Source: OSTI; NTIS; GPO Dep.

The fracture toughness of brittle intermetallic compounds can be improved by ductile-phase reinforcements. Effectiveness of the ductile phase in bridging cracks, and therefore increasing, the composite toughness, is known qualitatively to depend upon the extent of debonding, between the two phases. Numerical crack-growth simulations are used here to provide semi-quantitative predictions of the influence of interfacial debonding on the macroscopic stress-displacement behavior and, hence, the fracture toughness of an idealized Pb/glass composite. The interfacial toughness required to cause debonding, characterized by a constant critical energy release rate, is varied parametrically. As expected, higher interfacial toughness results in less interphase debonding, higher composite strength, and greater ductile-phase constraint. Consequently, the increase in ductile-phase triaxiality can potentially accelerate internal v[illegible]formation and growth or facilitate cleavage fracture, either of which would likely decrease the toughness of the composite.

7085 (UCRL-JC–114841) **High damage threshold anti-reflectors by physical vapor deposited amorphous fluoropolymer.** Chow, R.; Spragge, M.K.; Loomis, G.E.; Thomas, I.M.; Rainer, F.; Ward, R.L.; Kozlowski, M.R. Lawrence Livermore National Lab., CA (United States). Nov 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-931054–2: 25. Boulder damage symposium: annual symposium on optical materials for high-power lasers, Boulder, CO (United States), 27-29 Oct 1993). Order Number DE94004865. Source: OSTI; NTIS; GPO Dep.

High laser-resistant anti-reflective coatings were made from an amorphous fluoropolymer (Teflon AF2400) material by physical vapor deposition. Single layers of Teflon AF2400 were thermally deposited in a vacuum chamber. Refractive index and adhesion of the coatings were determined as a function of deposition rate (2 to 20 Å/s), substrate temperature (20 to 200C), and glow-discharge bias potential (−1500 to 1500 V). An anti-reflective coating of an amorphous fluoropolymer (Teflon AF2400) had a laser resistance of > 47 J/cm^2 (1.06 μm, 3-ns pulselength) and is transparent from 200 nm to 1600 nm. The majority of the coatings had a 1.30 refractive index, similar to that of the bulk material. Scanning electron microscopy and preliminary nuclear magnetic resonance observations indicated that morphological changes caused the variations in

the refractive index rather than compositional changes. The coatings adhered to fused silica and silicon wafers under normal laboratory handling conditions. Scotch tape with 12.6 gr/mm tension was sufficient to pull off every coating from fused silica substrates.

7086 (WHC-SD-NR-TRP–016) **Asbestos-cement panels test report, 100K Area, Hanford, Washington.** Moustafa, S.E. (Wiss, Janney, Elstner and Associates, Inc., Seattle, WA (United States)). Westinghouse Hanford Co., Richland, WA (United States); Wiss, Janney, Elstner and Associates, Inc., Seattle, WA (United States). 1 Dec 1993. 110p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94004828. Source: OSTI; NTIS; GPO Dep.

The 105KE/105KW reactor facilities were constructed in the mid-1950s. The 105KE/105KW fuel-basin roof panels are in a radiation controlled area where there is smearable contamination. The roof panels in all of the inspected areas were constructed from corrugated asbestos-cement (A/C) panels. The corrugated A/C roof panels exhibit common signs of aging including cracking, chipping, spalling, or a combination of these processes. Westinghouse Hanford Company (WHC) has engaged Wiss, Janney, Elstner Associates, Inc. (WJE) to perform laboratory and field tests on A/C roof panels of the 105KW building and also to make recommendations for panel replacement, maintenance, or upgrade that will maintain the structural integrity of the roof panels for an additional 20 years of service. This report contains the results of laboratory and in-situ testing performed by WJE. A Roof Proof Load Test Plan was prepared for WJE and approved by WHC. Conclusions and recommendations based on test results are presented for the 190-KE wall panels and 105KW roof panels.

7087 (WINCO–1125) **Effects of rebar and concrete construction joints on the migration of 4 M HNO_3 in concrete test cylinders.** Brewer, K.N. Westinghouse Idaho Nuclear Co., Inc., Idaho Falls, ID (United States). Jun 1993. 49p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-84ID12435. Order Number DE94000723. Source: OSTI; NTIS; GPO Dep.

This report describes experiments designed to test the effects of rebar and concrete cold joints on the migration of 4M HNO_3. Worst case conditions were used in these tests to determine rebar and cold joint effects on acid migration and concrete degradation. These conditions include: (1) a 1 inch diameter hole directly over the rebar/cold joint to simulate a leak, (2) a nitric acid concentration of 4 molar, (3) a continuous supply of fresh acid contacting the rebar/cold joint, and (4) a continuous agitation of the acid caused by stirring. These unrealistic test,conditions were used to intentionally cause as much concrete damage as possible in the short time required to perform the test (4–6 months).

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Refer also to citation(s) 7936

7088 (LBL–34259) **Chemical Sciences Division: Annual report 1992.** Lawrence Berkeley Lab., CA (United States). Oct 1993. 83p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94004941. Source: OSTI; NTIS; INIS; GPO Dep.

The Chemical Sciences Division (CSD) is one of twelve research Divisions of the Lawrence Berkeley Laboratory, a Department of Energy National Laboratory. The CSD is composed of individual groups and research programs that are organized into five scientific areas: Chemical Physics, Inorganic/Organometallic Chemistry, Actinide Chemistry, Atomic Physics, and Physical Chemistry. This report describes progress by the CSD for 1992. Also included are remarks by the Division Director, a description of work for others (United States Office of Naval Research), and appendices of the Division personnel and an index of investigators. Research reports are grouped as Fundamental Interactions (Photochemical and Radiation Sciences, Chemical Physics, Atomic Physics) or Processes and Techniques (Chemical Energy, Heavy-Element Chemistry, and Chemical Engineering Sciences).

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Refer also to citation(s) 6137, 6231, 6581, 7122, 7192, 7353, 7363, 7430

7089 (AECS-PR/RSS–60) **Determination of U^{235}/U^{238} ratio in natural uranium using gamma spectroscopy.** Othman, Ibrahim (Atomic Energy Commission, Damascus (Syrian Arab Republic). Dept. of Radiation Protection and Nuclear Safety); Mahrouka, Mohammad. Atomic Energy Commission, Damascus (Syrian Arab Republic). Dept. of Radiation Protection and Nuclear Safety. Sep 1993. 30p. (In Arabic). Order Number DE94610032. Source: OSTI; NTIS (US Sales Only); INIS.

The ratio of U^{235}/U^{238} was determined by gamma spectroscopy. The 185.7, 143.8 and 163.4 KeV peaks were used to determine the U^{235} concentration. To determine U^{238} the 1001 KeV of peak from Pa^{231} was used. The ratio of these radionuclides were calculated in different types of samples including sediment, uranium ore, geological samples and soil samples. The ratio was found to be 0.045 for studied samples and 0.05 for uranium ore. (author). 12 refs., 9 tabs.

7090 (CONF-931108–29) **Structural analysis of amorphous phosphates using high performance liquid chromatography.** Sales, B.C.; Boatner, L.A.; Chakoumakos, B.C.; McCallum, J.C.; Ramey, J.O.; Zuhr, R.A. Oak Ridge National Lab., TN (United States). [1993]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Fall meeting of the Materials Research Society (MRS); Boston, MA (United States); 29 Nov - 3 dec 1993. Order Number DE94004791. Source: OSTI; NTIS; GPO Dep.

Determining the atomic-scale structure of amorphous solids has proven to be a formidable scientific and technological problem for the past 100 years. The technique of high-performance liquid chromatography (HPLC) provides unique detailed information regarding the structure of partially disordered or amorphous phosphate solids. Applications of the experimental technique of HPLC to phosphate solids are reviewed, and examples of the type of information that can be obtained with HPLC are presented. Inorganic phosphates encompass a large class of important materials whose applications include: catalysts, ion-exchange media, solid electrolytes for batteries, linear and nonlinear optical components, chelating agents, synthetic replacements for bone and teeth, phosphors, detergents, and fertilizers. Phosphate ions also represent a unique link between living systems and the inorganic world.

7091 (DOE/ER/13552–10) **Analysis and computer tools for separation processes involving nonideal mixtures: Progress report, December 1, 1992–November 30, 1993.** Lucia, A. Clarkson Univ., Potsdam, NY (United States). Dept. of Chemical Engineering. 12 Jul 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER13552. Order Number DE94004162. Source: OSTI; NTIS; GPO Dep.

This research is concerned with developing mathematical analysis, numerical analysis, and computer tools for separation processes involving nonideal, homogeneous, and heterogeneous multi-component mixtures. Progress, organized in terms of mathematical analysis, numerical analysis, and algorithmic development, is summarized.

7092 (DOE/ER/13823–T2) **Development of measurement capabilities for the thermophysical properties of energy-related fluids: Annual report, December 1, 1990–November 30, 1991.** National Inst. of Standards and Technology, Gaithersburg, MD (United States). Chemical Science and Technology Lab. [1991]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI05-88ER13823. Order Number DE94004399. Source: OSTI; NTIS; GPO Dep.

The objectives of this project are to develop state-of-the-art experimental apparatus that can be used to measure the thermophysical properties of a wide range of fluids and fluid mixtures important to the energy, chemical, and energy-related industries and to carry out carefully selected benchmark measurements on key systems. The measurement capabilities to be developed include new apparatus for transport properties, thermodynamic properties, phase equilibria properties, and dielectric properties.

The specific measurement capabilities to be developed are: thermal conductivity apparatus; vibrating wire viscometer; dual-sinker densimeter; high-temperature vibrating tube densimeter; dynamic phase equilibria apparatus; apparatus for dilute solutions; total-enthalpy flow calorimeter; and dielectric constant apparatus. The research also includes benchmark experimental measurements on pure and mixed alternative refrigerants and their mixtures with lubricants, on aqueous solutions, and on carefully selected systems consisting of species of diverse size (methane + neopentane) and polarity (methane + ammonia) that are important for the development of predictive models for energy-related fluids.

7093 (DOE/ER/14320–1) **New high temperature plasmas and sample introduction systems for analytical atomic emission and mass spectrometry: Progress report: January 1, 1993–December 31, 1993.** Montaser, A. George Washington Univ., Washington, DC (United States). Office of Sponsored Research. [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-93ER14320. Order Number DE94004564. Source: OSTI; NTIS; INIS; GPO Dep.

In this research, new high-temperature plasmas and new sample introduction systems are explored for rapid elemental and isotopic analysis of gases, solutions, and solids using mass spectrometry and atomic emission spectrometry. During the period January 1993–December 1993, emphasis was placed on (a) analytical investigations of atmospheric-pressure helium inductively coupled plasma (He ICP) that are suitable for atomization, excitation, and ionization of elements possessing high excitation and ionization energies; (b) simulation and computer modeling of plasma sources to predict their structure and fundamental and analytical properties without incurring the enormous cost of experimental studies; (c) spectrosopic imaging and diagnostic studies of high-temperature plasmas; (d) fundamental studies of He ICP discharges and argon-nitrogen plasma by high-resolution Fourier transform spectrometry; and (e) fundamental and analytical investigation of new, low-cost devices as sample introduction systems for atomic spectrometry and examination of new diagnostic techniques for probing aerosols. Only the most important achievements are included in this report to illustrate progress and obstacles. Detailed descriptions of the authors' investigations are outlined in the reprints and preprints that accompany this report. The technical progress expected next year is briefly described at the end of this report.

7094 (DOE/FTR–93018109) **Travel to USSR for symposium on Coherent Raman Spectroscopy: Foreign trip report, September 15–28, 1990.** Farrow, R.L.; Rahn, L.A. Sandia National Labs., Livermore, CA (United States). 13 Dec 1991. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DR00789. Order Number DE93018109. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Three invited papers describing diagnostics research conducted at SNL, Livermore, were presented at the International Symposium on Coherent Raman Spectroscopy, in Samarkand, U.S.S.R. We participated in many useful technical discussions with leading foreign scientists in nonlinear spectroscopy. After the conference, we spent four additional days visiting laboratories in Moscow, Triozk, and Minsk. The visits included tours of numerous experiments involving coherent nonlinear Raman spectroscopy and degenerate four-wave mixing.

7095 (IS–5085) **Application of non-radiometric methods to the determination of plutonium: Literature review conducted for the Buried Waste Integrated Program.** Edelson, M.C. Ames Lab., IA (United States). 5 Mar 1992. 39p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005568. Source: OSTI; NTIS; INIS; GPO Dep.

This literature review was motivated by discussions that took place during a review of contamination control technologies proposed for INEL (buried waste). It should be a useful tool in identifying non-radiation measurement techniques for Pu and Am such as ICP-MS, which should fulfill the following criteria: apparatus must be field deployable; up to 100 samples per day; and lower levels of detection and required time must be listed. The sensitivity of ICP and RIMS is compared against that needed for contamination monitoring at INEL. Only Pu-241, with a required detection limit of 400 ppt, would challenge the sensitivity of ICP-MS; Pu-238 would be easily determined. The need to determine Pu-238 and Am-241 in the presence of U-238 and Pu-241 seems to preclude the possibility of using laser ablation ICP-MS for Pu monitoring. ICP-AES and -LEAFS methods may not have enough sensitivity to determine Pu-238 at 2 ppb level with confidence, but RIMS (resonance ionization mass spectroscopy) should be adequate. 47 refs, figs.

7096 (IS-T–1614) **Instrumental development of novel detection and separation methods for capillary electrophoresis.** Garner, T. Ames Lab., IA (United States). Jul 1993. 117p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005554. Source: OSTI; NTIS; INIS; GPO Dep.

After a general introduction, this thesis is divided into 3 parts: indirect fluorescence detection of sugars separated by capillary zone electrophoresis with visible laser excitation, absorption detection in capillary electrophoresis by fluorescence energy transfer, and increased selectivity for electrochromatography by dynamic ion exchange.

7097 (IS-T–1644) **Measurement of elemental speciation by liquid chromatography – inductively coupled plasma mass spectrometry (LC-ICP-MS) with the direct injection nebulizer (DIN).** Shum, S. Ames Lab., IA (United States). May 1993. 168p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005261. Source: OSTI; NTIS; GPO Dep.

This thesis is divided into 4 parts: elemental speciation, speciation of mercury and lead compounds by microbore column LC-ICP-MS with direct injection nebulization, spatially resolved measurements of size and velocity distributions of aerosol droplets from a direct injection nebulizer, and elemental speciation by anion exchange and size exclusion chromatography with detection by ICP-MS with direct injection nebulization. Tabs, figs, refs.

7098 (IS-T–1656) **An axial approach to detection in capillary electrophoresis.** Taylor, J.A. Ames Lab., IA (United States). May 1993. 131p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005556. Source: OSTI; NTIS; GPO Dep.

Our approach involves on-axis illumination of the compounds inside the capillary detection region and is applied to absorbance and fluorescence detection. Absorbance measurements were made by focussing an incident laser beam into one capillary end; by using signals collected over the entire length of analyte band, this enhances the analytical path length of conventional absorbance detection 60x. This instrument offers a 15x improvement in detection limits. Three fluorescence detection experiments are discussed, all of which involve insertion of an optical fiber into capillary. The first uses a high refractive index liquid phase to obtain total internal reflectance along capillary axis, this reducing light scatter. The second uses a charge-coupled device camera for simultaneous imaging of a capillary array (this may be useful in genome sequencing, etc.). The third is a study of fluid motion inside the capillary under pressure-driven and electroosmotic flow. The thesis is divided into four parts. Figs, tabs.

7099 (IS-T–1658) **Optimization of separation and detection schemes for DNA with pulsed field slab gel and capillary electrophoresis.** McGregor, D.A. Ames Lab., IA (United States). Jul 1993. 155p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005555. Source: OSTI; NTIS; GPO Dep.

The purpose of the Human Genome Project is outlined followed by a discussion of electrophoresis in slab gels and capillaries and its application to deoxyribonucleic acid (DNA). Techniques used to modify electroosmotic flow in capillaries are addressed. Several separation and detection schemes for DNA via gel and capillary electrophoresis are described. Emphasis is placed on the elucidation of DNA fragment size in real time and shortening separation times to approximate real time monitoring. The migration of DNA fragment bands through a slab gel can be monitored by UV absorption at 254 nm and imaged by a charge coupled device (CCD) camera. Background correction and immediate viewing of band positions to interactively change the field program in pulsed-field gel electrophoresis are possible throughout the separation. The use of

absorption removes the need for staining or radioisotope labeling thereby simplifying sample preparation and reducing hazardous waste generation. This leaves the DNA in its native state and further analysis can be performed without de-staining. The optimization of several parameters considerably reduces total analysis time. DNA from 2 kb to 850 kb can be separated in 3 hours on a 7 cm gel with interactive control of the pulse time, which is 10 times faster than the use of a constant field program. The separation of ΦX174RF DNA-HaeIII fragments is studied in a 0.5% methyl cellulose polymer solution as a function of temperature and applied voltage. The migration times decreased with both increasing temperature and increasing field strength, as expected. The relative migration rates of the fragments do not change with temperature but are affected by the applied field. Conditions were established for the separation of the 271/281 bp fragments, even without the addition of intercalating agents. At 700 V/cm and 20°C, all fragments are separated in less than 4 minutes with an average plate number of 2.5 million per meter.

7100 (IS-T–1667) **Chemically modified polymeric resins for separation of cations, organic acids, and small polar molecules by high performance liquid chromatography.** Morris, J.B. Ames Lab., IA (United States). Jul 1993. 181p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005548. Source: OSTI; NTIS; GPO Dep.

This thesis is divided into 4 parts: a review, ion chromatography of metal cations on carboxylic resins, separation of hydrophilic organic acids and small polar compounds on macroporous resin columns, and use of eluent modifiers for liquid chromatographic separation of carboxylic acids using conductivity detection.

7101 (IS-T–1668) **Chemically modified polymeric resins for solid-phase extraction and group separation prior to analysis by liquid or gas chromatography.** Schmidt, L.W. Ames Lab., IA (United States). Jul 1993. 124p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005550. Source: OSTI; NTIS; INIS; GPO Dep.

Polystyrene divinylbenzene was modified by acetyl, sulfonic acid, and quaternary ammonium groups. A resin functionalized with an acetyl group was impregnated in a PTFE membrane and used to extract and concentrate phenolic compounds from aqueous samples. The acetyl group created a surface easily wetted, making it an efficient adsorbent for polar compounds in water. The membrane stabilized the resin bed. Partially sulfonated high surface area resins are used to extract and group separate an aqueous mixture of neutral and basic organics; the bases are adsorbed electrostatically to the sulfonic acid groups, while the neutraons are adsorbed hydrophobically. A two-step elution is then used to separate the two fractions. A partially functionalized anion exchange resin is used to separate organic acids and phenols from neutrals in a similar way. Carboxylic acids are analyzed by HPLC and phenols by GC.

7102 (KAERI/TR–324/93) **Preparation and characterization of polystyrene-bounded catalyst.** Lee, Han Soo (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Chung, Hong Suk; Kang, Hwee Suk; Kim, Young Ik. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jan 1993. 86p. (In Korean). Order Number DE94610090. Source: OSTI; NTIS (US Sales Only); INIS.

The hydrophobic catalyst is employed for the gas-liquid exchange reaction which is of interet in hydrogen isotope separation process. The support materials for the hydrophobic catalyst are in general polymer, e.g., PTFE or polystyrene. In this study, polystyrene was employed due to its easiness of manufacture and control. For the preparation of polymer beads, the factors influencing the polymer properties comprise degree of crosslinkage, stirring speed, surfactant and its concentration, ratio of organic to aqueous phase volume, fraction of solvent in organic phase excluding monomer, and solvent properties. The platinum was impregnated on the prepared polymer support followed by implementation of hydrogen isotope exchange reaction. The result implied that the polymer prepared with n-amylalcohol as a solvent was the most appropriate, that was induced by comparing the mass transfer coefficients. (Author).

7103 (KFK–5117) **The measurement of the chemically mobile fraction of lead in soil using isotopic dilution analysis.** Kirchhoff, J.; Brand, J.; Schuettelkopf, H. Kernforschungszentrum Karlsruhe GmbH (Germany). Hauptabteilung Sicherheit; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Schadstoff- und Abfallarme Verfahren (PSA). Dec 1992. 48p. (In German). Order Number DE94734011. Source: OSTI; NTIS (US Sales Only); INIS.

The chemically available fraction of lead in eight soils measured by isotopic dilution analysis using ^{212}Pb ranged from 7 to 16% of the total content of lead in soil. The soluble fractions achieved values up to 63% of the total content in 1 M NH_4NO_3, 1 M $MgCl_2$ and 0.05 M DTPA solutions. Increasing the contact time between water and soil, the water-soil ratio from 1:1 to 5:1 and increasing the temperature of the soil-water suspension raised the chemically available fraction in soil. Comparing various soil parameters and the mobile fraction of lead, only pH shows a significant correlation. The amphoteric character of lead causes a minimum of mobility about pH 6; pH-values below are responsible for the higher mobility of lead as Pb^{2+}, at pH-values above 6 soluble hydroxy and humic acid complexes are formed. (orig.)

7104 (LA-UR–93-3930) **Zeeman laser interferometry for detection and chemical analysis.** Johnston, R.G. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940341–3: 4. laser applications to chemical analysis meeting, Jackson Hole, WY (United States), 8-11 Mar 1994). Order Number DE94003963. Source: OSTI; NTIS; GPO Dep.

Zeeman interferometry has a number of applications for ultrasensitive detection and chemical analysis, including refractive index detection, micro-thermometry, thermooptic spectroscopy, and light scattering.

7105 (ORNL/TM–12625) **Atom probe field ion microscopy and related topics: A bibliography 1992.** Russell, K.F.; Godfrey, R.D.; Miller, M.K. Oak Ridge National Lab., TN (United States). Dec 1993. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94003475. Source: OSTI; NTIS; GPO Dep.

This bibliography contains citations of books, conference proceedings, journals, and patents published in 1992 on the following types of microscopy: atom probe field ion microscopy (108 items); field emission microscopy (101 items); and field ion microscopy (48 items). An addendum of 34 items missed in previous bibliographies is included.

7106 (PNL-SA–22232) **Contaminant analysis automation demonstration proposal.** Dodson, M.G.; Schur, A.; Heubach, J.G. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9310100–6: Human Factors and Ergonomics Society meeting, Seattle, WA (United States), 11-15 Oct 1993). Order Number DE94003717. Source: OSTI; NTIS; GPO Dep.

The nation-wide and global need for environmental restoration and waste remediation (ER&WR) presents significant challenges to the analytical chemistry laboratory. The expansion of ER&WR programs forces an increase in the volume of samples processed and the demand for analysis data. To handle this expanding volume, productivity must be increased. However. The need for significantly increased productivity, faces contaminant analysis process which is costly in time, labor, equipment, and safety protection. Laboratory automation offers a cost effective approach to meeting current and future contaminant analytical laboratory needs. The proposed demonstration will present a proof-of-concept automated laboratory conducting varied sample preparations. This automated process also highlights a graphical user interface that provides supervisory, control and monitoring of the automated process. The demonstration provides affirming answers to the following questions about laboratory automation: Can preparation of contaminants be successfully automated?; Can a full-scale working proof-of-concept automated laboratory be developed that is capable of preparing contaminant and hazardous chemical samples?; Can the automated processes be seamlessly integrated and controlled?; Can

the automated laboratory be customized through readily convertible design? and Can automated sample preparation concepts be extended to the other phases of the sample analysis process? To fully reap the benefits of automation, four human factors areas should be studied and the outputs used to increase the efficiency of laboratory automation. These areas include: (1) laboratory configuration, (2) procedures, (3) receptacles and fixtures, and (4) human-computer interface for the full automated system and complex laboratory information management systems.

7107 (PNL-SA–22739) **Isotopic trace analysis by atomic mass spectrometry.** Stoffels, J.J. Pacific Northwest Lab., Richland, WA (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9310240–1: 20. annual meeting of the Federation of Analytical Chemistry and Spectroscopy Societies, Detroit, MI (United States), 17-22 Oct 1993). Order Number DE94003730. Source: OSTI; NTIS; INIS; GPO Dep.

Text for vugraphs; no vugraphs included.

All the production facilities at Hanford are now shut down. However, the legacy from half a century of plutonium production includes 177 underground storage tanks of up to one million gallons each containing the largest accumulation of high-level radioactive waste in what used to be called "the free world." Hanford's new mission, in addition to a spectrum of ongoing research and development, is radioactive waste management and environmental restoration. Isotope-ratio mass spectrometry will continue to be an essential tool in monitoring the progress of that mission.

7108 (WSRC-TR–93-607) **The Savannah River Technology Center, a leader in sensor technology.** Stewart, W.C. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004036. Source: OSTI; NTIS; GPO Dep.

This publication highlights the capabilities and achievements of the Savannah River Technology Center in the field of sensor technology. Sensors are developed to provide solutions for environmental and chemical analysis. Most of their sensor systems are based upon fiber optics. Fiber optic probes function in three main modes: as a reflected light probe, from opaque samples; as a transreflectance probe, which sample light reflected back from samples which can pass light; and a flow cell, which monitors light transmitted through a path which passes the process stream being tested. The sensor group has developed fiber optic based temperature probes, has combined fiber optics with sol-gel technology to monitor process streams using chemical indicators, has done development work on slip stream on-line sampling of chemical process streams, has developed software to aid in the analysis of chemical solutions, and has applied this technology in a wide range of emerging areas.

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Refer also to citation(s) 6016, 6454, 6968, 7058, 7062, 7087, 7102, 7128, 7130, 7135, 7390, 7483, 7746

7109 (CONF-9305134–, pp. 139-148) **Dielectric studies of fluids with reentrant resonators.** Goodwin, A.R.H. (National Institute of Standards and Technology, Gaithersburg, MD (United States)); Moldover, M.R. Argonne National Lab., IL (United States). 1993. DOE Contract AI05-88ER13823. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The authors have used a reentrant radio-frequency (rf) cavity as a resonator operating near 375 MHz to measure changes in the dielectric constant of fluids within it. The utility of these measurements was demonstrated by determining the dipole moment of 1,1,1,2,3,3-hexafluoropropane, a candidate replacement refrigerant (denoted R236ea) and by detecting the phase boundaries in the mixture $[(1-x)C_2H_6 + xCO_2]$, for the mole fraction $x = 0.492$. The densities of the coexisting phases of the mixture were determined using the Clausius-Mossotti relation which has errors on the order of 0.5% in this application. To test the accuracy of the present techniques, the rf resonator was calibrated with helium and then used to redetermine the molar polarizability A_ϵ of argon. The results were in excellent agreement with published values. The design of the reentrant resonator makes it suitable for use with corrosive fluids at temperature up to 400°C.

7110 (CONF-9305134–, pp. 263-270) **Partial control of complex chemical processes I. Control of fluidized catalytic cracker.** Shinnar, R. (City College of New York, New York, NY (United States)); Rinard, I. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

A detailed dynamic model of a fluidized catalytic cracker has been developed that allows evaluation of the impact of different designs, control configurations, catalyst and feed composition and control strategies on the control of a fluid cracker. The present paper deals with the existence and the topology of multiple steady states. It is shown that in some cases five steady states can exist. Further, some of these can be close together in terms of the input operating space. Present trends in operating conditions (higher regenerator temperatures and higher catalyst activities) increase the likelihood that desirable operating conditions are in the regions where such multiplicities occur. It is shown that catalytic combustion promoters can eliminate or reduce this problem. The paper also shows that conventional control structures can lead to input multiplicities and that the choice of additional control variables in the primary matrix should depend on operating conditions.

7111 (DOE/CE/23810–20D) **Accelerated screening methods for determining chemical and thermal stability of refrigerant-lubricant mixtures: Part 2, Experimental comparison and verification of methods: Quarterly technical progress report, 1 March 1993–30 June 1993.** Kauffman, R. Dayton Univ., OH (United States). Research Inst. Oct 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91CE23810. Order Number DE94003664. Source: OSTI; NTIS; GPO Dep.

Initial research focused on conductivity measurements to perform in heated situ degradation measurements of CFC-12/mineral oil and HCFC-22/mineral oil mixtures at 175C in sealed glass tubes. Tungsten rods were sealed into round bottoms of the sealed tubes to provide electrical connections for in situ conductivity measurements. Steel, Cu and W were used as catalysts as well as conductivity probes. Conductivity measurements have been made with both ac and dc voltage inputs. Preliminary results indicate that in situ conductivity measurements correlate with refrigerant/lubricant degradation as determined by other analytical techniques (color, gas chromatography). Some of the continuous conductivity measurement tests appear to accelerate as well as monitor the refrigerant/lubricant degradation. W posts with a valve steel catalyst appear optimum combination for conductivity measurements. Ferric fluoride catalysts and differential thermal analysis were also investigated. Initial tests indicate that the ferric fluoride catalyst has potential for testing lubricant stability at temperatures lower than 175C . Differential thermal analysis have minimal potential for in situ measurements of long-term refrigerant/lubricant degradation processes.

7112 (DOE/ER/13538–8) **Metallocarboxylate chemistry: Progress report, November 17, 1992–November 22, 1993.** Gibson, D.H. Louisville Univ., KY (United States). Dept. of Chemistry. 22 Nov 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-86ER13538. Order Number DE94004412. Source: OSTI; NTIS; GPO Dep.

Research is focused on bimetallic compounds of late transition metals with carbon dioxide or CO_2-containing bridging ligands. The compounds are models for catalytic intermediates in CO_2 fixation/activation processes. Thermolysis was studied. Re, Fe, and Sn complexes were studied.

7113 (DOE/ER/13564–12) **Controlled synthesis of polyenes by catalytic methods: Progress report, December 1, 1992–November 30, 1993.** Schrock, R.R. Massachusetts Inst. of Tech., Cambridge, MA (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER13564. Order Number DE94004168. Source: OSTI; NTIS; GPO Dep.

Four studies are reported: living cyclopolymerization of diethyl dipropargylmalonate by Mo(CH-t-Bu)(NAr)[OCMe(CF_3)$_2$]$_2$ in dimethoxyethane, effect of chain length on conductivity of polyacetylene, nonlinear optical analysis of a series of triblock copolymers containing model polyenes, and synthesis of bifunctional hexafluoro-t-butoxide Mo species and their use as initiators in ROMP reactions.

7114 (DOE/ER/13775–5) **[Group transfer and electron transfer reactions of organometallic complexes]: Summary of research accomplished in 1993.** State Univ. of New York, Buffalo, NY (United States). Dept. of Chemistry. [1993]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-87ER13775. Order Number DE94004963. Source: OSTI; NTIS; GPO Dep.

In the past year the research on mechanisms of electron transfer processes between organometallic complexes has continued to progress with emphasis on two electron processes and on reactions of organometallic radicals. This summary will highlight the research on: (1) halide transfer reactions, (2) alkyl and acyl transfer reactions and (3) reactions of seventeen-electron organometallic complexes. At this point some conclusions on the transfer of hydrogen, halogen and methyl as the cation, radical and anion can be made. For each group, transfer as the cation is more facile. For hydrogen, transfer as the hydride is considerably slower, but H· transfers nearly as rapidly as H^+. Methyl could be transferred as CH_3^+ or CH_3^-, but not as the radical. Halogens transfer readily as X^+, more slowly as X· and not at all as X^-.

7115 (DOE/ER/14165–T1) **The formation of silica, alumina and zirconia supported high surface area monometallic and bimetallic catalysts: Progress report.** Gonzalez, R.D. Tulane Univ., New Orleans, LA (United States). Dept. of Chemical Engineering. [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-91ER14165. Order Number DE94004402. Source: OSTI; NTIS; GPO Dep.

During the current granting period, 12/01/92–11/30/93, studies have progressed along four fronts: (1) Preparation of high surface area Pt/SiO_2 catalysts; (2) preparation of high surface area Pt/Al_2O_3 catalysts; (3) preparation of high surface area promoted zirconia superacid catalysts and, (4) stabilization and sintering of porous Pt/SiO_2 catalysts. In addition to these current studies a major review article on previously funded DOE research has been completed and will appear in Catalysis Reviews. Results of these studies are briefly described.

7116 (DOE/ER/45503–1) **[Surface structure and stereochemical properties of self-assembled monolayer materials]: [Progress report].** Princeton Univ., NJ (United States). Dec 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-93ER45503. Order Number DE94004960. Source: OSTI; NTIS; GPO Dep.

This document reports the progress the authors have made in support of their proposal to generate well-characterized, well-ordered organic surfaces and to impinge upon the array of oriented organic molecules a well-collimated beam of radical atoms at a well-defined angle of incidence. Using the intensity of helium atom diffraction from the organic surface as a measure of the number of unreacted molecules at the surface, the authors will measure the rate of the reaction. They will then vary the angle of incidence of the reactive atom beam and repeat the measurement. In this manner they plan to map out the reactivity of the molecules on the surface as a function of the angle of incidence of the reactive moiety. To carry out this experiment requires that two fields of research be brought together: (1) molecular beam technology and (2) the science/art of growing well-ordered organic surfaces. The first half of this report describes recent helium diffraction results from molecular beam deposited organic monolayers (structural layer characterization work). The second half reports progress in constructing and characterizing the reactive atom (oxygen) beam source.

7117 (DOE/ER/60844–1) **Experimental assessment and modeling of organic compound interphase mass-transfer rates in multiphase subsurface systems: Progress report.** Weber, W.J. Jr.; Abriola, L.M. Michigan Univ., Ann Arbor, MI (United States). 15 Mar 1990. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER60844. Order Number DE94005134. Source: OSTI; NTIS; GPO Dep.

During the initial eight month period of this grant, work has been conducted on all facets of the project. Significant progress has been made in the design, construction and testing of the experimental apparatus. Investigation of methods for characterizing the physical forms of non-aqueous phase liquid (NAPL) residuals (globules or blobs) has led to a narrowing of possible approaches. Development of a numerical simulator that accomodates multiphase transport with mass transfer rate interactions is well underway.

7118 (DOE/PC/91030–T6) **Methyl chloride via oxyhydrochlorination of methane: Quarterly technical progress report No. 5, October–December 1992.** Dow Corning Corp., Carrollton, KY (United States). Jun 1993. 48p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91030. Order Number DE94004732. Source: OSTI; NTIS; GPO Dep.

Objective is to develop a process for converting light alkane gases to methyl chloride via oxyhydrochlorination using highly selective, stable catalysts (CuO based) in fixed-bed reactors designed to remove the large amount of heat generated, so as to control the reaction temperature. The proposed PFD for this unit was described to management, and the PDU PFD is currently being expanded into a P&ID with a subcontractor.

7119 (IS-T–1616) **The gas-phase thermal chemistry of tetralin and related model systems.** Malandra, J. Ames Lab., IA (United States). May 1993. 165p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005277. Source: OSTI; NTIS; GPO Dep.

The thesis is divided into 5 papers: gas-phase thermal decomposition of tetralin; flash vacuum pyrolysis of 3-benzocycloheptenone and 1,3, 4,5-tetrahydro-2-benzothiepin-2,2-dioxide (model systems for gas-phase pyrolysis of tetralin); high-temperature gas-phase reactions of o-allylbenzyl radicals generated by flash vacuum pyrolysis of is(o-allylbenzyl) oxalate; flash vacuum pyrolysis of 1,4-diphenylbutane; and flash vacuum pyrolysis of o-allyltoluene, o-(3-butenyl)toluene and o-(pentenyl)toluene were also used.

7120 (IS-T–1682) **Fundamental studies of hydrogen interaction with supported meta and bimetallic catalysts.** Bhatia, S. Ames Lab., IA (United States). 7 Dec 1993. 178p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-7405-ENG-82. Grant CBT-8507418. Order Number DE94004887. Source: OSTI; NTIS; GPO Dep.

The thesis is divided into 3 parts: interaction of H with silica supported Ru catalysts (high pressure in situ NMR), in situ NMR study of H interaction with supported Ru-group IB bimetallic catalysts, and in-situ NMR study of H effects on silica-supported Pt, Rh and Ru catalysts.

7121 (LBL–31792) **NMR studies of the conformation and motion of tetrahydrofuran in graphite intercalation compounds.** Caplan, D.F. (Lawrence Berkeley Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States). Nov 1991. 96p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94004011. Source: OSTI; NTIS; GPO Dep.

The behavior of tetrahydrofuran (THF) molecules intercalated in graphite layers in compounds Cs(THF)$_{1.3}C_{24}$ and K(THF)$_{2.5}C_{24}$ was studied by proton NMR. The graphite layers in these compounds impose a uniform ordering on the THF molecules, giving rise to sharp NMR spectra. Experimental and simulated proton NMR spectra were used to investigate geometry, orientation and conformation of intercalated THF, and to determine whether pseudorotation, a large amplitude low-frequency vibration observed in

gaseous THF, can also occur in the constrained environment provided by the graphite intercalation compounds. Deuterium and multiple quantum proton NMR spectra were also simulated in order to determine if these techniques could further refine the proton NMR results.

7122 (LBL–34872) **Coordination chemistry of two heavy metals: I, Ligand preferences in lead(II) complexation, toward the development of therapeutic agents for lead poisoning: II, Plutonium solubility and speciation relevant to the environment.** Neu, M.P. (Lawrence Berkeley Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States); Lawrence Livermore National Lab., CA (United States). Nov 1993. 205p. Sponsored by USDOE, Washington, DC (United States);Seaborg (Glenn T.) Inst. for Transactinium Science, Livermore, CA (United States). DOE Contract AC03-76SF00098 ; W-7405-ENG-48. Order Number DE94004203. Source: OSTI; NTIS; INIS; GPO Dep.

The coordination chemistry and solution behavior of the toxic ions lead(II) and plutonium(IV, V, VI) have been investigated. The ligand pK_as and ligand-lead(II) stability constants of one hydroxamic acid and four thiohydroxamic acids were determined. Solution thermodynamic results indicate that thiohydroxamic acids are more acidic and slightly better lead chelators than hydroxamates, e.g., N-methylthioaceto-hydroxamic acid, $pK_a = 5.94$, $\log\beta_{120} = 10.92$; acetohydroxamic acid, $pK_a = 9.34$, $\log\beta_{120} = 9.52$. The syntheses of lead complexes of two bulky hydroxamate ligands are presented. The X-ray crystal structures show the lead hydroxamates are di-bridged dimers with irregular five-coordinate geometry about the metal atom and a stereochemically active lone pair of electrons. Molecular orbital calculations of a lead hydroxamate and a highly symmetric pseudo octahedral lead complex were performed. The thermodynamic stability of plutonium(IV) complexes of the siderophore, desferrioxamine B (DFO), and two octadentate derivatives of DFO were investigated using competition spectrophotometric titrations. The stability constant measured for the plutonium(IV) complex of DFO-methylterephthalamide is $\log\beta_{110} = 41.7$. The solubility limited speciation of ^{242}Pu as a function of time in near neutral carbonate solution was measured. Individual solutions of plutonium in a single oxidation state were added to individual solutions at pH = 6.0, T = 30.0, 1.93 mM dissolved carbonate, and sampled over intervals up to 150 days. Plutonium solubility was measured, and speciation was investigated using laser photoacoustic spectroscopy and chemical methods.

7123 (PNL-SA–22666) **Homolytic bond dissociation energies for C-H bonds adjacent to sulfur and aromatic moieties: The effects of substituents of C-H bond strengths of the benzylic positions in coal model compounds.** Alnajjar, M.S. (Pacific Northwest Lab., Richland, WA (United States)); Franz, J.A.; Gleicher, G.J.; Truksa, S.; Bordwell, F.; Zhang, Xian-Man. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930904–15: 7. international conference on coal science, Banff (Canada), 12-17 Sep 1993). Order Number DE94004315. Source: OSTI; NTIS; GPO Dep.

Sulfur-containing compounds are precursors for thiyl radicals at coal liquefaction temperatures due to the weakness of The and S-S bonds. Thiyl radicals play important roles in hydrogen atom shuttling between benzylic positions and catalyze the cleavage and the formation of strong C-C bonds. Although many reactions of thiyl and other sulfur-containing radicals are qualitatively understood, the homolytic bond dissociation energies (EDE's) and the thermochemistry associated with many key high molecular weight hydrocarbon and sulfur-containing organic structures important to coal is lacking because they are inappropriate for gas-phase techniques. The measurement of BDE's has been proven to be difficult even in the simplest of molecules.

7124 (PNL-SA–23135) **Membrane reactor/separator: A design for Bi-molecular reactant addition.** Tonkovich, A.Y.; Secker, R.B.; Reed, E.L.; Cox, J.L.; Roberts, G.L. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931043–8: 8. symposium on separation science and technology for energy applications, Knoxville, TN (United States), 24-28 Oct 1993). Order Number DE94004295. Source: OSTI; NTIS; GPO Dep.

A membrane reactor (MBR) is used to investigate the effect of selective reactant addition on series-parallel reaction networks, such as the oxidative dehydrogenation of ethane to ethylene. Ethylene is favored in an oxygen-lean environment, while excess oxygen favors the formation of combustion products. Control of the reactant ratio (ethane to oxygen) is crucial to both the overall selectivity and the hydrocarbon conversion. Traditional reactor designs co-feed the bimolecular reactants at the top of the reactor at some preset feed ratio. The MBR uses a tube (porous alumina membrane) and shell configuration. One reactant is fed at the top of a catalyst bed packed within the membrane core, while the other reactant permeates into the tube along the length of the reactor via an imposed pressure drop. The reactant ratio is large at the top of the MBR, which leads to high selectivities; as the oxygen is consumed, it is replenished via downstream permeation to improve the ethane conversion. The MBR and a plug flow reactor (PFR) are evaluated at 600C, with identical space velocities, and using a magnesium oxide catalyst doped with samarium oxide. At low to moderate reactant feed ratios, the ethylene yield in the MBR exceeds the PFR; at higher feed ratios, the PFR gives higher ethylene yields.

7125 (SAND–93-1159C) **Hydrogen uptake into silicon from an ECR plasma.** Wampler, W.R.; Barbour, J.C. Sandia National Labs., Albuquerque, NM (United States). [1993]. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9311104–14: 40. national symposium of the American Vacuum Society (AVS), Orlando, FL (United States), 15-19 Nov 1993). Order Number DE94003771. Source: OSTI; NTIS; GPO Dep.

The concentration of hydrogen in solution near the surface of silicon exposed to an electron cyclotron resonance (ECR) plasma was determined by measuring the flux of hydrogen permeating to subsurface microcavities. The energy and flux of hydrogen impinging onto the surface from the plasma was also measured. A model is described which predicts the concentration of hydrogen in solution from the energy and flux of the impinging hydrogen. The measured solution concentrations were $\sim 10^{-9}$ H/Si at 600°C and $\sim 10^{-8}$ H/Si at 400°C, in fairly good agreement with the model. The absence of accumulation of immobile hydrogen near the surface indicates that lattice defects, which strongly trap hydrogen, were not produced by the ECR plasma. This study establishes a connection between the properties of the ECR plasma and the concentration of hydrogen in silicon samples exposed to the plasma, which allows improved control over passivation of defects and dopants.

7126 (SAND–93-2514C) **Alkylene-bridged polygerm- and polygermsilsesqui-oxanes: New hybrid organic-inorganic materials.** Jamison, G.M. (Sandia National Labs., Albuquerque, NM (United States)); Loy, D.A.; Zender, G.; Shea, K.J. Sandia National Labs., Albuquerque, NM (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940301–5: 207. spring national meeting of the American Chemical Society, San Diego, CA (United States), 13-18 Mar 1994). Order Number DE94005096. Source: OSTI; NTIS; GPO Dep.

Alkylene-bridge polygerm- and polygermsilsequioxanes have been formed by hydrolysis-condensation of their corresponding $(EtO)_3M(CH_2)_nGe(OEt)_3$ monomers under HCl- and NEt_3-catalyzed conditions in ethanol. Solid state ^{13}C and ^{29}Si NMR indicate the retention of the alkylene bridging moiety during polymerization. The resulting aerogels are mesoporous materials with high surface areas. Incorporation of the short ethylene bridging unit results in higher surface areas than when heylene bridges are present. The porous nature of hexylene-bridged hybrid network $[Si(CH_2)_6GeO_3]_n$ appears insensitive to the acidic or basic nature of the catalyst employed in it formation, in contrast to its polysilsesquioxane counterpart. Work is underway to determine the origin of porosity in these materials, and to characterize xerogel materials generated from these monomers.

7127 (SAND–93-7112C) **Variation of stability constants of thorium and uranium oxalate complexes with ionic strength.** Erten, H.N (Florida State Univ., Tallahassee, FL (United States).

Dept. of Chemistry); Mohammed, A.K.; Choppin, G.R. Sandia National Labs., Albuquerque, NM (United States). [1993]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931201–7: 4. international conference on chemistry and migration behavior of actinides and fission products in the geosphere, Charleston, SC (United States), 12-17 Dec 1993). Order Number DE94005100. Source: OSTI; NTIS; GPO Dep.

Extraction of Th(IV) and UO_2^{2+} by a solution of TTA and HDEHP, respectively, in toluene was used to obtain stability constants of their oxalate complexes in 1, 3, 5, 7 and 9 M ionic strength ($NaClO_2$) solutions. The complexes formed were the MOx, MHOx, MOx_2 and $M(HOx)_2$ (M = Th, UO_2) species. The values were analyzed by the Specific Interaction Theory and agreed to $I \leq 3$ M but required an additional term for fitting at $I > 3$ M.

4004 Electrochemistry

Refer also to citation(s) 6759, 6760, 6840, 6957

4005 Photochemistry

Refer also to citation(s) 7050

7128 (DOE/ER/14105–4) **Photochemistry in constrained spaces: Zeolites and layered double metal hydroxides: Progress report, August 1, 1992–September 15, 1993.** Dutta, P.K. Ohio State Univ., Columbus, OH (United States). Dept. of Chemistry. [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER14105. Order Number DE94004958. Source: OSTI; NTIS; GPO Dep.

The authors have continued their research in the field of preparation and reactions of photochemical systems in zeolites and layered lithium aluminates. The study on zeolite focused on faujasitic zeolites. The experimental strategy is to build $Ru(bpy)_3^{2+}$ inside the supercage and examine the photoelectron transfer from this entrapped complex to acceptor molecules (viologens) through the ring openings. The effort on layered lithium aluminum double hydroxides (LDH) of composition $LiAl_2(OH)_6{}^+X^-$ has been on incorporation of photoactive molecules in these interlayers, with particular emphasis on pyrene and Zn porphyrins.

7129 (IS-T–1657) **Investigations into ultraviolet matrix-assisted laser desorption.** Heise, T.W. Ames Lab., IA (United States). Jul 1993. 105p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005265. Source: OSTI; NTIS; GPO Dep.

Matrix-assisted laser desorption (MALD) is a technique for converting large biomolecules into gas phase ions. Some characteristics of the commonly used uv matrices are determined. Solubilities in methanol range from 0.1 to 0.5 M. Solid phase absorption spectra are found to be similar to solution, but slightly red-shifted. Acoustic and quartz crystal microbalance signals are investigated as possible means of uv-MALD quantitation. Evidence for the existence of desorption thresholds is presented. Threshold values are determined to be in the range of 2 to 3 MW/cm^2. A transient imaging technique based on laser-excited fluorescence for monitoring MALD plumes is described. Sensitivity is well within the levels required for studying matrix-assisted laser desorption, where analyte concentrations are significantly lower than those in conventional laser desorption. Results showing the effect of film morphology, particularly film thickness, on plume dynamics are presented. In particular, MALD plumes from thicker films tend to exhibit higher axial velocities. Fluorescent labeling of protein and of DNA is used to allow imaging of their uv-MALD generated plumes. Integrated concentrations are available with respect to time, making it possible to assess the rate of fragmentation. The spatial and temporal distributions are important for the design of secondary ionization schemes to enhance ion yields and for the optimization of ion collection in time-of-flight MS instruments to maximize resolution. Such information could also provide insight into whether ionization is closely associated with the desorption step or whether it is a result of subsequent collisions with the matrix gas (e.g., proton transfer). Although the present study involves plumes in a normal atmosphere, adaptation to measurements in vacuum (e.g., inside a mass spectrometer) should be straightforward.

7130 (IS-T–1674) **Quenching of the excited state of hydrated Europium(III) ions by electron transfer.** Christensen, K. Ames Lab., IA (United States). Aug 1993. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005553. Source: OSTI; NTIS; INIS; GPO Dep.

This thesis explores the oxidation-reduction chemistry of the excited state of Eu(III) ions, $^*Eu_{aq}^{3+}$, in aqueous solutions. Evidence is presented for the quenching of $^*Eu^{3+}$ by reductive electron transfer. It is concluded that $^*Eu^{3+}$ is not a strong energy transfer reagent. The reactivity of $^*Eu_{aq}^{3+}$ is compared with that of $^*UO_2^{2+}$.

7131 (LBL–34918) **Infrared diode laser studies of the products from the reaction $CH_2(\tilde{X}^3B_1) + O_2$ and from the near-UV photolysis of CH_3NCS.** Alvarez, R.A. Lawrence Berkeley Lab., CA (United States). Dec 1993. 101p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94005217. Source: OSTI; NTIS; GPO Dep.

Absolute yields of CO, CO_2, and H_2CO formed in reaction of triplet methylene ($\tilde{X}\ ^3B_1 \equiv CH_2$) with O_2 were determined using a flash kinetic spectrometer. CH_2 radicals were generated by excimer laser photolysis of ketene and product formation was monitored by time-resolved infrared diode laser absorption. Reaction was carried out in a static gas cell at room temperature at 1–25 torr. Measured product yields were CO, 0.34 $\pm$ 0.06; CO_2, 0.40 $\pm$ 0.08 H_2CO, 0.16 $\pm$ 0.04. Rate constants for production of CO and CO_2 were equivalent to the published rate constant for removal of CH_2. Indirect evidence indicated that yield of OH is 0.30 $\pm$ 0.05. Ultraviolet spectrum of methyl isothiocyanate ($CH_3NCS \equiv$ MITC) and quantum yield for dissociation into methyl isocyanide (CH_3NC) and atomic sulfur at 308 nm, Φ 0.98 $\pm$ 0.24, were measured. MITC is widely used as a fumigant and readily enters the atmosphere during and after application. Results indicate that photodissociation by sunlight is an effective pathway for removal of MITC from atmosphere. A mechanism is proposed to account for the observed formation of methyl isocyanate (CH_3NCO) as a secondary product in controlled laboratory studies.

4006 Radiation Chemistry

7132 (ANL–93/43) **Radiolytic and radiolytically induced generation of gases from synthetic wastes: Final report.** Meisel, D.; Jonah, C.D.; Kapoor, S.; Matheson, M.S.; Sauer, M.C. Jr. Argonne National Lab., IL (United States). Oct 1993. 101p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94005197. Source: OSTI; NTIS; GPO Dep.

To better understand the processes leading to the generation and release of gases from waste tanks, the authors studied the radiolytic and thermal generation of H_2, N_2O, N_2, O_2, and NH_3 in nonradioactive waste simulant solutions and slurries. The radiolytic sources for H_2 are e_{aq}^- and its predecessors and H atoms. Radiolysis of the water generates some H_2 and an additional amount comes from the hydrogen abstraction reaction $H + RH \rightarrow H_2 + R\cdot$. Nitrate scavenges e_{aq}^- and its predecessors whereas nitrite is the major H-atom scavenger. Computer modeling shows that if $[NO_3^-]$ is above 0.5 M, and $[NO_2^-]$ is above 2M, the addition of other scavengers will have little effect on the yield of H_2. In the presence of organic molecules O_2 is efficiently destroyed. Small yields of ammonia were measured and the yields increase linearly with dose. The nitrogen in NH_3 comes from organic chelators. The yields of gases in solution depend only weakly on temperature. The rate of thermal generation of gases increases upon preirradiation, reaches a maximum, and then declines. The known radiolytic degradation products of chelators, NTA, IDA, glycolate, glyoxylate, formaldehyde, formate, oxalate, and hydroxylainine were examined for their roles in the thermal generation of H_2 and N_2O at 60°C. In solution or slurry only radiolytically produced Pd intermediate strongly retains H_2. Radiolytic yields of N_2O are strongly reduced by Cr(III). In irradiated slurry, loose and tight gas were found. The loose gas could be removed by bubbling from the slurry, but the tight gas could be released only by dissolution of the slurry.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 6137, 6200, 7095

7133 (LA-UR–93-3281) **Characterization of the nitrate complexes of Pu(IV) using absorption spectroscopy, ^{15}N NMR, and EXAFS.** Veirs, D.K.; Smith, C.A.; Zwick, B.D.; Marsh, S.F.; Conradson, S.D. Los Alamos National Lab., NM (United States). [1993]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-930905–21: Actinides '93, Santa Fe, NM (United States), 19-24 Sep 1993). Order Number DE94003980. Source: OSTI; NTIS; GPO Dep.

Nitrate complexes of Pu(IV) are studied in solutions containing nitrate up to 13 molar (M). Three major nitrato complexes are observed and identified using absorption spectroscopy, ^{15}N nuclear magnetic resonance (NMR), and extended x-ray absorption fine structure (EXAFS) as $Pu(NO_3)_2^{2+}$, $Pu(NO_3)_4$, and $Pu(NO_3)_6^{2-}$. The possibility that $Pu(NO_3)_1^{3+}$, $Pu(NO_3)_3^{1+}$ and $Pu(NO_3)_5^{1-}$ are major species in solution is not consistent with these results and an upper limit of 0.10 can be set on the fraction for each of these three nitrate complexes in nitrate containing solutions. Fraction of the three major species in nitric acid over the 1–13 M range were calculated from absorption spectra data. The fraction of $Pu(NO_3)_6^{2-}$ as a function of nitric acid concentration is in good agreement with the literature, whereas the fraction of $Pu(NO_3)_2^{2+}$ and $Pu(NO_3)_4$ species differ from previous studies. We have modeled the chemical equilibria up to moderate ionic strength (< 6 molal) using the specific ion interaction theory (SM. Comparison of our experimental observations to literature stability constants that assume the presence of mononitrate species is poor. Stability constant at zero ionic strength for the dinitrato complex is determined to be $\log(\beta_2^0)=3.77 \pm 0.14$ (2σ).

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 6424, 7372, 7747

7134 (CONF-9305134–, pp. 205-212) **Characterization of thermal plasmas by laser light scattering.** Snyder, S.C. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Lassahn, G.D.; Reynolds, L.D.; Fincke, J.R. Argonne National Lab., IL (United States). 1993. DOE Contract AC07-76ID01570. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Characterization of an atmospheric pressure free-burning arc discharge and a plasma jet by lineshape analysis of scattered laser light is described. Unlike emission spectroscopy, this technique provides direct measurement of plasma gas temperature, electron temperature and electron density without the assumption of local thermodynamic equilibrium (LTE). Plasma gas velocity can also be determined from the Doppler shift of the scattered laser light. Radial gas temperature, electron temperature and electron density profiles are presented for an atmospheric pressure argon free-burning arc discharge. These results show a significant departure from LTE in the arc column, contradicting results obtained from emission spectroscopy. Radial gas temperature and gas velocity profiles in the exit plane of a subsonic atmospheric pressure argon plasma jet are also presented. In this case, the results show the plasma jet is close to LTE in the center, but not in the fringes. The velocity profile is parabolic.

7135 (IS-T–1687) **Gas phase thermochemistry of organogermanium compounds.** Engel, J.P. Ames Lab., IA (United States). 7 Dec 1993. 140p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94004885. Source: OSTI; NTIS; GPO Dep.

A variety of silyl- and alkyl-germylene precursors have been synthesized and subsequently pyrolyzed in the gas phase. Arrhenius parameters were obtained employing a pulsed-stirred flow reactor for these unimolecular decompositions. These precursors are divided into two major categories by mechanism of germylene extrusion: α-elimination precursors and germylacetylenes. The extrusion of germylenes from germylacetylene precursors is of primary interest. A mechanism is proposed employing a germacyclopropene intermediate. Evidence supporting this mechanism is presented. In the process of exploring germylacetylenes as germylene precursors, an apparent dyatropic rearrangement between germanium and silicon was observed. This rearrangement was subsequently explored.

7136 (UCRL-JC–113809) **Uncertainties in the characterization of the thermal environment of a solid rocket propellant fire.** Diaz, J.C. Lawrence Livermore National Lab., CA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940312–25: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94002023. Source: OSTI; NTIS; GPO Dep.

There has been an interest in developing models capable of predicting the response of systems to Minuteman (MM) III third-stage solid propellant fires. Input parameters for such an effort include the boundary conditions that describe the fire temperature, heat flux, emissivity, and propellant burn rate. In this study scanning spectroscopy and pyrometry were used to infer plume temperatures. Each diagnostic system possessed strengths and weaknesses. The intention was to use various supportive methods to infer plume temperature and emissivity, because no one diagnostic had proven capabilities for determining temperature under these conditions. Furthermore, these diagnostics were being used near the limit of their applicability. All these points created some uncertainty in the data collected.

7137 (UCRL-JC–115320) **The addition of molecular oxygen to hydroperoxy-propyl radicals.** Bozzelli, J.W. (New Jersey Inst. of Tech., Newark, NJ (United States)); Pitz, W.J. Lawrence Livermore National Lab., CA (United States). Oct 1993. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-931076–4: Fall meeting of the Western States Section of the Combustion Institute, Menlo Park, CA (United States), 18-19 Oct 1993). Order Number DE94003662. Source: OSTI; NTIS; GPO Dep.

The addition of hydroperoxy-alkyl radicals to molecular oxygen is an important process leading to chain branching in the low temperature oxidation of paraffins and at conditions related to autoignition and engine knock. The product channels for the addition of hydroperoxy-propyl radicals to molecular oxygen were estimated using bimolecular QRRK analysis and transition state theory. Thermochemistry of all the relevant species was estimated using group additivity. The main products at 1–15 atm are stabilization, alkyl carbonyl + OH, and in some cases an olefinic hydroperoxide + HO_2. Product channels for each of the three hydroperoxy-alkyl isomers were analyzed and rate expressions for each channel were calculated for a series of pressures over a temperature range of 600–1600 K.

42 ENGINEERING

Refer also to citation(s) 6083

7138 (KAERI/AR–369/93) **Image processing technology for nuclear facilities.** Lee, Jong Min (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Lee, Yong Beom; Kim, Woong Ki; Park, Soon Young. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). May 1993. 116p. (In Korean). Order Number DE94610692. Source: OSTI; NTIS (US Sales Only); INIS.

Digital image processing technique is being actively studied since microprocessors and semiconductor memory devices have been developed in 1960's. Now image processing board for personal computer as well as image processing system for workstation is developed and widely applied to medical science, military, remote inspection, and nuclear industry. Image processing technology which provides computer system with vision ability not only recognizes nonobvious information but processes large information and therefore this technique is applied to various fields like remote measurement, object recognition and decision in adverse

environment, and analysis of X-ray penetration image in nuclear facilities. In this report, various applications of image processing to nuclear facilities are examined, and image processing techniques are also analysed with the view of proposing the ideas for future applications. (Author).

7139 (SAND–93-2378) **Manufacturing technology: A Sandia Technology Bulletin.** Leonard, J.; Doran, L.; Floyd, H.L.; Goetsch, B.; Parrott, L. (eds.). Sandia National Labs., Albuquerque, NM (United States). Dec 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94005320. Source: OSTI; NTIS; GPO Dep.

This item is a copy of the Dec., 1993 issue of Manufacturing Technology, a Sandia Technology Bulletin. It has information on a number of different projects being conducted by Sandia in the general area of manufacturing sciences. Topics addressed include the following: center for information-technology manufacturing gears up, luctrative flat-panel display market targeted; researchers make copper stick to teflon, patterned adhesion may provide ideal conductor/substrate combination for microcircuits; contact algorithm enhances simulation of manufacturing processes, algorithm efficiently handles previously difficult analyses of punching and cutting operations; national machine tool partnership rolls into action, national laboratories share technology to boost US machine-tool industry; closed-loop MAST system eyes robotic manufacturing, fast, accurate, low-cost sensor demonstrated on furnace brazing.

4202 Facilities, Equipment, and Techniques

Refer also to citation(s) 6124, 6130, 6131, 6210, 6286, 6287, 6302, 6462, 6865, 6883, 6912, 6915, 7326, 7327, 7328, 7364, 7366, 7386, 7916

7140 (BNL–49639) **On the liquefaction failure of an earth dam.** Simos, N. (Brookhaven National Lab., Upton, NY (United States)); Reich, M.; Costantino, C.J. Brookhaven National Lab., Upton, NY (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9310102–38: 4. energy natural phenomena hazards mitigation conference, Atlanta, GA (United States), 19-22 Oct 1993). Order Number DE94003992. Source: OSTI; NTIS; GPO Dep.

In an effort to better assess the potential for sliding and liquefaction failure of earthen dams when subjected to earthquake loadings, a dynamic finite element approach focusing on these two failure mechanisms as well as on the vital role of the pore water pressure was undertaken. The constitutive response of the granular soil skeleton and its coupling with the fluid phase is formulated based on the Blot dynamic equations of motion. The constitutive model for the soil material was assumed to be linear with nonlinear terms included in the hysteretic damping terms. Despite the linear character of this theoretical model, one can still draw important conclusions regarding the stability and the liquefaction resistance of the cross-section. As an example, a hypothetical earth dam constructed over a saturated soil layer was considered. The steady state conditions of in-situ stress and pore pressure distributions in both the embankment and the foundation are evaluated and implemented in the stability and liquefaction criteria in conjunction with the dynamic analysis. The latter is carried out in the frequency domain and it reflects the response of the dam-foundation system to a seismic excitation. The computational aspect of the study is performed with finite element analysis. A transmitting boundary formulation for the two phase material was used to treat the infinite space problem. It is anticipated that the intensity of the earthquake input and certain soil properties have a profound effect on the failure susceptibility of the dam section. To address the uncertainties regarding the true values of such parameters, the analysis considered them parametrically.

7141 (CONF-9305134–, pp. 103-110) **Fully plastic fracture mechanics for plane strain crack growth.** McClintock, F.A. (Massachusetts Institute of Technology, Cambridge, MA (United States)); Kim, Y.J.; Parks, D.M. Argonne National Lab., IL (United States). 1993. DOE Contract FG02-85ER13331. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

A theoretical framework is given for designing possibly cracked structures to remain ductile under accidental overloads. For non-hardening, fully-plastic plane strain crack growth in a number of geometries and loadings, near tip fields are characterized by three parameters: the slip line angle θ_s and the normal stress σ_s and shear displacement δu_s across the slip line. These parameters are found in terms of the far-field geometries and loadings through slip line fields or at least upper bound analyses based on circular arcs. Then the crack growth criterion in terms of the crack tip opening angle (CTOA) is proposed as a function of near tip parameters and material properties. Experiments are suggested to determine the dependence of the CTOA on those variables.

7142 (CONF-9305316–, pp. 100-103) **High speed arc spray process.** Morishita, T. (Whitco Japan, Tokyo (Japan)); Owari, T. 19 May 1993. 118p. (In Japanese). From 57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993. In *Proceedings of the 57th (Spring, 1993) National Congress of Japan Thermal Spraying Society.* Order Number DE94731734. Source: OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan.

The present report describes high-speed arc spray using Model-9000 arc jet of Hobart-Tafa Technologies, Inc., USA. The points improved are such that the wire supply mechanism is applied with a servo-motor and a light-weight spray gun was designed. The convergence of atomizing air is improved to markedly enhance attaching efficiency. Although the accelerating energy of particles has been low compared with spray energy, the amount of atomizing air was increased to enhance the spray energy and make the particle speed larger by 50% than ever. The results obtained are improvement in the surface roughness of coating, reduction in the oxidation of particles, realization of high coating density, reduction in coating contraction, etc. As uniform high-temperature particles are accelerated in high speed in this high-speed spray, they are well attached to the surface of complex shape. Even when the spray distance is greatly changed, the energy loss is small and coating of stable quality can be obtained. As examples of application, spray against black liquid recovering boiler tube is cited to show high-temperature corrosion resistance and wear resistance. 3 refs., 11 figs.

7143 (CONF-9311103–2) **Some considerations on robotics for environmental friendliness.** Pin, F.G. Oak Ridge National Lab., TN (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Institute of Electrical and Electronics Engineers (IEEE) and Tsukuba international workshop on advanced robotics; Tsukuba (Japan); 8-9 Nov 1993. Order Number DE94003497. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents a series of considerations regarding the use and potential of robotic devices for supporting humans in a variety of tasks, while maintaining, if not improving, environmental friendliness. One of the main considerations brought forward here relates to the type of human-support functions which the robots are, or will be, expected to perform, and from this, a clear differentiation appears between robots designed to replace humans in environments that were engineered in the past for best human functionality, and robots designed to take functions in the future, in environments which could be better engineered for large-scale human-robot synergy. Other considerations discussed involve the "life-cycle" cleanliness of robotic systems, including the materials needs for their construction, their operation, their disposal and, more importantly, their energy consumption which will impact the cycle of natural resources utilization. These considerations are discussed using a variety of possible robotic systems applications in contexts varied as manufacturing, energy recovery and production, emergency situations handling, traffic improvement, waste management, agriculture, and space exploration. In all these applications, the operation costs and complexity of the robots seem to vary in inverse proportion to the amount of engineering that is feasible to make the task environment more robot-friendly, but with no seemingly direct impact on the potential for environmental friendliness of the robots.

7144 (CONF-940143–2) **Human factors in telemanipulation: Perspectives from the Oak Ridge National Laboratory experience.** Draper, J.V. Oak Ridge National Lab., TN (United States). Jan 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Society of Photo-Optical Instrumentation Engineers (SPIE) conference on teleoperation and space telerobotics; Boston, MA (United States); 15 Jan 1994. Order Number DE94004739. Source: OSTI; NTIS; INIS; GPO Dep.

Personnel at the Robotics and Process Systems Division (RPSD) of the Oak Ridge National Laboratory (ORNL) have extensive experience designing, building, and operating teleoperators for a variety of settings, including space, battlefields, nuclear fuel reprocessing plants, and hazardous waste retrieval. In the course of the last decade and a half, the RPSD designed, built, and operated 4 telemanipulators (M-2, ASM, LTM, CESAR arm) and operated another half dozen (M-8, Model 50, TOS SM-229, RM-10, PaR 5000, BilArm 83A). During this period, human factors professionals have been closely integrated with RPSD design teams, investigating telemanipulator feedback and feed forward, designing cockpits and control rooms, training users and designers, and helping to develop performance specifications for telemanipulators. This paper presents a brief review of this and other work, with an aim towards providing perspectives on some of the human factors aspects of telemanipulation. The first section of the paper examines user tasks during supervisory control and discusses how telemanipulator responsiveness determines the appropriate control metaphor for continuous manual control. The second section provides an ecological perspective on telemanipulator feedback and feed-forward. The third section briefly describes the RPSD control room design approach and how design projects often serve as systems integrators.

7145 (DOE/PC/91161–T6) **Development of a coal-fired combustion system for industrial process heating applications: Quarterly technical progress report, January 1993–March 1993.** Vortec Corp., Collegeville, PA (United States). 30 Apr 1993. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91161. Order Number DE94003289. Source: OSTI; NTIS; GPO Dep.

This advanced combustion system research program is for the development of innovative coal-fired process heaters which can be used for high temperature melting, smelting and waste vitrification processes. The process heater concepts to be developed are based on advanced glass melting and ore smelting furnaces developed and patented by Vortec Corporation. The process heater systems to be developed have multiple use applications; however, the Phase III research effort is being focused on the development of a process heater system to be used for producing value added vitrified glass products from boiler/incinerator ashes and industrial wastes. The primary objective of the Phase III project is to develop and integrate all the system components, from fuel through total system controls, and then test the complete system in order to evaluate its potential marketability. During the current reporting period, a majority of the effort was spent performing the initial industrial proof-of-concept test and installing and integrating the Wet Electrostatic Precipitator (WESP). The other system modifications are well underway with the designs of the modifications to the batch/coal feed system being completed. A Purchase Order has been issued to a material conveying equipment vendor for the purchase of the batch/coal feeding equipment. The delivery and installation of the material conveying equipment is expected to occur in July and early August. The commercialization planning is continuing with the completion of a draft Business Plan. This plan is currently undergoing internal review, and will be submitted to Dawnbreaker, a DOE contracted small business consulting firm, for review.

7146 (KFK–5149) **Design and construction of a type testing and production test facility for HEPA filters to be installed in ventilation systems of German nuclear power plants.** Kuhn, W.; Fronhoefer, M.; Neuberger, M.; Wilhelm, J. Kernforschungszentrum Karlsruhe GmbH (Germany); Kernforschungszentrum Karlsruhe GmbH (Germany). Lab. fuer Aerosolphysik und Filtertechnik (LAF). May 1993. 43p. (In German). Order Number DE94734058. Source: OSTI; NTIS (US Sales Only); INIS.

High-efficiency particulate air filters (HEPA filters) in nuclear plants frequently constitute part of the last barrier separating potentially contaminated areas from the environment. Their failure may cause radioactive substances to be released. The sensitivity of the filter media employed, and the problems associated with manufacturing the HEPA filters normally used in nuclear plants, result in considerable differences in the quality of commercial HEPA filters. Aging of filter components during operation may greatly reduce the loading capacity of the entire filter. A relatively large number of HEPA filters were found to be defective at the end of service life. In order to be able to guarantee the removal efficiency of HEPA filters over a sufficient length of service life and under accident conditions, quality control measures must be introduced. Type tests of the HEPA filters to be used in nuclear plants must include a number of criteria beyond the loads imposed by the rated volumetric flow rate under the usual room air conditions. These criteria have been combined in a special type test (DIN 25 414), and passing this test should be made a prerequisite for the use of HEPA filters in nuclear plants. In addition, random inspections of production HEPA filters should be carried out to allow an adequate standard of quality to be guaranteed for a long time. (orig./GL)

7147 (LBL–34767) **Opportunities for high aspect ratio micro-electro-magnetic-mechanical systems (HAR-MEMMS) at Lawrence Berkeley Laboratory.** Hunter, S. (ed.). Lawrence Berkeley Lab., CA (United States). Oct 1993. 260p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9308178–: Opportunities for HAR-MEMMS at Lawrence Berkeley Laboratory, Berkeley, CA (United States), 3 Aug 1993). Order Number DE94003499. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains viewgraphs on the following topics: Opportunities for HAR-MEMMS at LBL; Industrial Needs and Opportunities; Deep Etch X-ray Lithography; MEMS Activities at BSAC; DNA Amplification with Microfabricated Reaction Chamber; Electrochemistry Research at LBL; MEMS Activities at LLNL; Space Microsensors and Microinstruments; The Advanced Light Source; Institute for Micromaching; IBM MEMS Interests; and Technology Transfer Opportunities at LBL.

7148 (PNL-SA–22415) **Comparison of dynamic analysis of a Schilling hydraulic manipulator with experimental results.** Baker, C.P. (Pacific Northwest Lab., Richland, WA (United States)); Lew, J.Y.; Evans, M.S.; Magee, D.P. Pacific Northwest Lab., Richland, WA (United States). Jul 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9307159–1: 9. international conference on mathematical and computer modelling, Berkeley, CA (United States), 26-29 Jul 1993). Order Number DE94004597. Source: OSTI; NTIS; INIS; GPO Dep.

Two independent models of the dynamics of a Schilling Titan II hydraulic manipulator were developed and compared in order to obtain an accurate model of the manipulator dynamics. These models will be used in the development of feedback control laws and active damping algorithms. One of the model is an analytical model which was developed "by hand" with the assistance of computer symbolic manipulation. The other is a numerical model developed using a commercially available dynamics code. The data from these models were then compared with experimental data from an actual Titan II manipulator.

7149 (SAND–93-1298C) **Parameter estimation by genetic algorithms.** Reese, G.M. Sandia National Labs., Albuquerque, NM (United States). 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9310196–2: 1993 MATLAB conference, Boston, MA (United States), 18-20 Oct 1993). Order Number DE94002924. Source: OSTI; NTIS; GPO Dep.

Test/Analysis correlation, or structural identification, is a process of reconciling differences in the structural dynamic models constructed analytically (using the finite element (FE) method) and experimentally (from modal test). This is a methodology for assessing the reliability of the computational model, and is very important in building models of high integrity, which may be used as predictive tools in design. Both the analytic and experimental models

evaluate the same quantities: the natural frequencies (or eigenvalues, (ω_i), and the mode shapes (or eigenvectors, φ). In this paper, selected frequencies are reconciled in the two models by modifying physical parameters in the FE model. A variety of parameters may be modified such as the stiffness of a joint member or the thickness of a plate. Engineering judgement is required to identify important frequencies, and to characterize the uncertainty of the model design parameters.

7150 (SAND–93-1419C) **Measurement of lateral launch loads on re-entry vehicles using SWAT.** Mayes, R.L. Sandia National Labs., Albuquerque, NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940146–1: 12. international modal analysis conference, Honolulu, HI (United States), 31 Jan - 3 feb 1994). Order Number DE94003109. Source: OSTI; NTIS; GPO Dep.

The Sum of Weighted Accelerations Technique (SWAT) has been developed at Sandia National Laboratories to infer dynamic forces acting on free elastic structures from acceleration measurements. A derivative of SWAT known as SWAT TEEM (Sum of Weighted Accelerations using Tome Eliminated Elastic Modes) is utilized. This paper describes experiments demonstrating how this technology can be applied to measure lateral launch loads on Reentry Vehicle (RV) payloads. A technique to determine the number of sensors and best locations is described. Experiments are performed to excite a structure to which a mockup RV is mounted. Acceleration measurements on the RV are used to reconstruct the lateral force acting at the RV base, and these results are compared to measured results.

7151 (SAND–93-1822) **Algorithms for treating redundancy in repairable and non-repairable systems.** Campbell, J.E. (Sandia National Labs., Albuquerque, NM (United States)); Longsine, D.E.; Atkins, J. Sandia National Labs., Albuquerque, NM (United States). Oct 1993. 75p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94005289. Source: OSTI; NTIS; GPO Dep.

This report presents equations and computational algorithms for analyzing reliability of several forms of redundancy in repairable and non-repairable systems. For repairable systems, active, standby, and R of N redundancy with and without repair are treated. For non-repairable systems, active, standby, and R of N redundancy are addressed. These equations can be used to calculate mean time between failures, mean time to repair, and reliability for complex systems involving redundancy.

7152 (SAND–93-2133) **BAG: A code for predicting the performance of a gas bag impact attenuation system for the PATHFINDER lander.** Cole, J.K.; Waye, D.E. Sandia National Labs., Albuquerque, NM (United States). Nov 1993. 57p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94003688. Source: OSTI; NTIS; GPO Dep.

The National Aeronautics and Space Administration (NASA) is planning to launch a network of scientific probes to Mars beginning in late 1996. The precursor to this network will be PATHFINDER. Decelerating PATHFINDER from the high speed of its approach to Mars will require the use of several deceleration techniques working in series. The Jet Propulsion Laboratory (JPL) has proposed that gas bags be used to cushion the payload's ground impact on Mars. This report presents the computer code, BAG, which has been developed to calculate the pneumatic performance of gas bag impact attenuators and the one-dimensional rigid-body dynamic performance of a payload during ground impact.

7153 (SAND–93-2571) **Pantex lightning study recommendations report.** Chen, K.C.; Merewether, K.O. Sandia National Labs., Albuquerque, NM (United States). Dec 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94005318. Source: OSTI; NTIS; GPO Dep.

A brief history of lightning protection at Pantex nuclear explosive areas (NEAs) is given. An assessment of current Pantex lightning protection at NEAs is summarized. Recommendations for further improvements in lightning protection are described.

7154 (SAND–93-2742C) **Graphical programming at Sandia National Laboratories.** McDonald, M.J. (Sandia National Labs., Albuquerque, NM (United States)); Palmquist, R.D.; Desjarlais, L. Sandia National Labs., Albuquerque, NM (United States). Sep 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9310216–4: 7. Deneb robotics user group meeting, Troy, MI (United States), 12-15 Oct 1993). Order Number DE94003803. Source: OSTI; NTIS; INIS; GPO Dep.

Sandia has developed an advanced operational control system approach, called Graphical Programming, to design, program, and operate robotic systems. The Graphical Programming approach produces robot systems that are faster to develop and use, safer in operation, and cheaper overall than alternative teleoperation or autonomous robot control systems. Graphical Programming also provides an efficient and easy-to-use interface to traditional robot systems for use in setup and programming tasks. This paper provides an overview of the Graphical Programming approach and lists key features of Graphical Programming systems. Graphical Programming uses 3-D visualization and simulation software with intuitive operator interfaces for the programming and control of complex robotic systems. Graphical Programming Supervisor software modules allow an operator to command and simulate complex tasks in a graphic preview mode and, when acceptable, command the actual robots and monitor their motions with the graphic system. Graphical Programming Supervisors maintain registration with the real world and allow the robot to perform tasks that cannot be accurately represented with models alone by using a combination of model and sensor-based control.

7155 (SVF–478) **Degassing and desalination with sulfite dosage and reverse osmosis.** Bauer, T. (AaF Energikonsult, Stockholm AB (Sweden)); Ohlsson, M. Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Sep 1993. 29p. (In Swedish). Order Number DE94730449. Source: OSTI; NTIS.

Degasification of excess water without the supply of steam has always caused certain problems. The most common methods require that steam or hot water at a temperature above 110 degrees C is available or that the water is electrically heated. The reason is that the most common techniques is based on thermal degasification. This project has been carried out in order to evaluate the possibilities of degassing the excess water without heating. The method is based on the fact that the sulphite reacts with the oxygen in the water and forms sulphate. By means of the RO-technique (Reversed Osmosis), the sulphate is removed from the excess water. The project has been performed in pilot plant scale. The advantage of this combinations is that, except for the degasification; the salt contents, particles, humus and collides are reduced, too. The degasification worked very well and the oxygen contents were reduced to <5 ppb at the laboratory tests. A stoichiometric surplus of sulphite of 30% compared to the oxygen contents was sufficient. The risk of the sulphate being stopped up on the membrane surfaces of the RO-equipment was very carefully observed. No such symptoms could be found during the tests. The tests were carried out at an intermittent operation and the long range effect is therefore not completely clear. The good results of the laboratory tests point at the fact that the technique has large prospects to become very useable. The construction of commercial plants has been based on this investigation. 3 refs, 4 figs

7156 (UCRL-CR–115038) **Summary of studies on filter clogging.** Tien, Chi. Lawrence Livermore National Lab., CA (United States). Sep 1993. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004209. Source: OSTI; NTIS; GPO Dep.

The dynamic behavior of clogged filters is characterized by the changes of the local collection efficiency and permeability of the media as functions of the extent of deposition. Relevant literature on this topic is reviewed in this report.

7157 (UCRL-ID–114849) **ARDEC transition armature study: Progress report No. 3, October 1–November 30, 1991.** Hawke, R.S. Lawrence Livermore National Lab., CA (United States). 13 May 1992. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94003370. Source: OSTI; NTIS; GPO Dep.

This third report covers the period October 1 to November 30, 1991. During this period the authors: (1) fabricated a test fixture for studying hybrid armature brush behavior, (2) reactivated a 140kJ, 1MA capacitor bank, (3) reactivated 25 channels digital data acquisition and reduction system and (4) concluded the use of a DNA funded railgun would serve as the most expedient means to acquire a railgun test bed. Fabrication of a plasma brush test fixture for studying the formation, evolution and stability of plasma brushes was completed. The fixture will serve to study plasma brush parameters, such as brush length and voltage drop, as a function of initial solid foil mass, gap size and current concentration. A 4OkV, 168μf, 140kJ capacitor bank capable of providing more than 1MA of current was reactivated. (The LLNL bank had been developed for opening switch research which was successfully completed.) The bank will be used to power the test fixture with 10μs, flat top current pulses. A 25 channel LeCroy digital data acquisition system interfaced to an LSI-11 and a Mini VAX computer was reactivated and brought on line to record the B-dot signals, voltages and current data from the test fixture. An evaluation of the most expedient means of obtaining a small bore railgun test bed for armature studies led to the conclusion that a portion of the DNA funded, LANL fabricated, LTS (Lethality Test System) railgun which was loaned to SNL, would be the best choice. A request to borrow the equipment for 3 years was initiated.

7158 (UCRL-ID–115027) **Criticality safety evaluation for Portsmouth X-345 High-Enriched-Uranium storage area.** Koponen, B.L. Lawrence Livermore National Lab., CA (United States). 20 Sep 1993. 106p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004807. Source: OSTI; NTIS; INIS; GPO Dep.

This report evaluates nuclear criticality safety for the High-Enriched Uranium storage area of the X-345 building of the Portsmouth Gaseous Diffusion Plant. The effects of loss of moderation or mass control are examined for storage units in or out of the storage receptacles. Recommendations are made for decreasing criticality hazards under some conditions of storage or handling considered to be hazardous.

7159 (UCRL-JC–115410) **A method for determining risk to ground facilities from aircraft accidents.** Kimura, C.Y.; Bennett, C.T. Lawrence Livermore National Lab., CA (United States). 10 Oct 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940312–28: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001605. Source: OSTI; NTIS; GPO Dep.

This paper has attempted to outline the steps necessary to perform a credible assessment of the risk to ground facilities from aircraft accidents. Some preliminary aircraft accident and operation data at the Amarillo International Airport in Texas was presented as an example. Future work would require estimating the location of the accidents as a function of distance from the runways and overlaying this estimate with the location of various ground facilities near Amarillo.

7160 (WAPD-T–2944) **A modified finite element procedure for underwater shock analysis.** Chan, S.K. Bettis Atomic Power Lab., West Mifflin, PA (United States). [1990]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-9010172–6: 61. shock and vibration symposium, Pasadena, CA (United States), 16-18 Oct 1990). Order Number DE94004449. Source: OSTI; NTIS; INIS; GPO Dep.

Using the regular finite element method for analyzing wave propagation problems presents difficulties: (a) The finite element mesh gives spurious reflection of the traveling wave and (b) Since a finite element model has to have a finite boundary, the wave is reflected by the outside boundary. However, for underwater shock problems, only the response of the structure is of major interest, not the behavior of the wave itself, and the shock wave can be assumed to be spherical. By taking advantage of the limited scope of the underwater shock problem, a finite element procedure can be developed that eliminates the above difficulties. This procedure not only can give very accurate solutions but it may also include structural nonlinearities and effect of cavitation.

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Refer also to citation(s) 6110, 6117, 6483, 6606, 6633, 6700, 7451, 7845, 7916

7161 (CONF-9305134–, pp. 24-31) **Effects of capillarity on microscopic flow in porous media.** Miksis, M.J. (Northwestern Univ., Evanston, IL (United States)); Tsai, T.M. Argonne National Lab., IL (United States). 1993. DOE Contract FG02-88ER13927. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Here the authors study the effect of capillarity on a microscopic problem related to foam flow in porous media: the transport of a bubble or drop through a constricted capillarity tube. The aim is to study the snap off process which occurs during the formation of a foam in a porous media. The authors illustrate the dynamics of the bubble for different initial data and for several different sets of the physical parameters.

7162 (CONF-9305134–, pp. 32-39) **Evolution of long wave disturbances in horizontal gas-liquid flows.** Kuru, W.C. (Univ. of Notre Dame, IN (United States)); Montalbano, E.D.; Brennecke, J.F.; McCready, M.J. Argonne National Lab., IL (United States). 1993. DOE Contract FG02-88ER13913. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

Coherent nonlinear interactions between linearly stable, long wavelength modes and modes that are near the peak of the growth rate are observed in experiments. These "side-band" interactions are suggested as the mechanism for initiation of long wavelength modes that are otherwise predicted to be stable from linear stability theory. Quadratic interaction theory is used to provide insight into when long wavelength modes will appear and how their frequency will be selected. The present work differs from previous side band analyses in that a low frequency mode is retained as a dominant mode (consistent with observations). Because of its relevance to continued growth of long wavelength disturbances and possibly slug formation and owing to its importance in modeling flow regime transitions, a discussion of the validity of the one-dimensional macroscopic equations and the boundary-layer equations as models of long wavelength disturbances for the two-layer stability problem is given in the context of laminar flow of a fluid over a solid wavy surface.

7163 (CONF-9305134–, pp. 56-62) **Effect of carrier gas pressure on condensation in a supersonic nozzle.** Wilemski, G. (Physical Sciences Inc., Andover, MA (United States)); Wyslouzil, B.E.; Gauthier, M.; Frish, M.B. Argonne National Lab., IL (United States). 1993. DOE Contract AC02-84ER13154 ; FG02-92ER14257. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The authors performed supersonic nozzle experiments with a fixed water or ethanol vapor pressure and varying amounts of nitrogen to test the hypothesis that carrier gas pressure affects the onset of condensation. Such an effect might occur if non-isothermal nucleation were important under conditions of excess carrier gas in the atmospheric pressure range, as has been suggested by Ford and Clement. Although a small increase in the condensation onset temperature was observed as the stagnation pressure was reduced from 3 to 0.5 atm, these changes cannot be attributed to any non-isothermal effects. To theoretically simulate the observed behavior, the authors performed calculations of nucleation and droplet growth in the nozzle that took into account the change in nozzle shape with carrier gas pressure due to boundary layer effects and the heat capacity of the flowing gas. Energy transfer limitations were neglected in calculating the nucleation

rates. The trend of the calculated results matched that of the experimental results very well. Thus, heat capacity and boundary layer effects are sufficient to explain the experimental onset behavior without invoking energy transfer limited nucleation. Beyond the onset location, the calculations overpredicted the rate of water condensation. Thus, inefficient cooling of larger, growing droplets may be influencing droplet growth rates. The conclusions about the rate of nucleation are consistent with those obtained recently using an expansion cloud chamber, but are at odds with results from thermal diffusion cloud chamber measurements.

7164 (CONF-9305134–, pp. 149-156) **Particle velocities in concentrated suspensions undergoing shear.** Kapoor, B. (Levich Institute, New York, NY (United States)); Acrivos, A. Argonne National Lab., IL (United States). 1993. DOE Contract FG02-90ER14139. Grant CTS-9012546. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

A theory is described for modeling the flow of concentrated suspensions. This theory has been successfully tested by measuring the particle velocities in such suspensions flowing under gravity along an inclined plate.

7165 (CONF-9305134–, pp. 164-171) **Wavelength selection in traveling-wave convection in a fluid mixture.** Surko, C.M. (Univ. of California, San Diego, La Jolla, CA (United States)); Eaton, K.D.; Baxter, G.W.; Iwata, K. Argonne National Lab., IL (United States). 1993. DOE Contract FG03-90ER14148. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The mechanisms by which a one-dimensional pattern of traveling waves changes wavelength (i.e. the Eckhaus instability) is studied in a binary fluid mixture. Propagating wavelength modulations develop when the Rayleigh number of the system is decreased below a wavelength-dependent threshold, commonly referred to as the Eckhaus boundary. These wavelength modulations increase in amplitude and narrow in spatial extent until they trigger the creation or annihilation of convection roll pairs and thereby change the average wavelength of the system. The authors find qualitatively different dynamics for wavelength-increasing events and wavelength-decreasing events; these differences are due to the strong wavelength dependence of the group velocity.

7166 (CONF-9305134–, pp. 197-204) **Microscopic image processing system for measuring nonuniform film thickness profiles: Image scanning ellipsometry.** Liu, A.H. (Rensselaer Polytechnic Institute, Troy, NY (United States)); Plawsky, J.L.; Wayner, P.C. Jr. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The long-term objective of this research program is to determine the stability and heat transfer characteristics of evaporating thin films. The current objective is to develop and use a microscopic image-processing system (IPS) which has two parts: an image analyzing interferometer (IAI) and an image scanning ellipsometer (ISE). The primary purpose of this paper is to present the basic concept of ISE, which is a novel technique to measure the two dimensional thickness profile of a non-uniform, thin film, from several nm up to several μm, in a steady state as well as in a transient state. It is a full-field imaging technique which can study every point on the surface simultaneously with high spatial resolution and thickness sensitivity, i.e., it can measure and map the 2-D film thickness profile. The ISE was tested by measuring the thickness profile and the refractive index of a nonuniform solid film.

7167 (CONF-9305134–, pp. 229-236) **Experiments on scalar mixing and transport.** Warhaft, Z. (Sibley School of Mechanical and Aerospace Engineering, Ithaca, NY (United States)). Argonne National Lab., IL (United States). 1993. DOE Contract FG02-88ER13929. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The author provides an overview of his recent work on passive (temperature) scalar mixing in both homogeneous and inhomogeneous turbulent flows. He shows that for homogeneous grid generated turbulence, in the presence of a linear temperature profile, the probability density function (pdf) of the temperature fluctuations has broad exponential tails, while the pdf of velocity is Gaussian. However, in the absence of a scalar gradient the pdf of temperature is Gaussian. This new result sheds insight into the fundamentals of turbulent mixing as well as to the nature of the velocity field. It is also shown that the spectrum of the temperature fluctuations has a scaling region that is consistent with Kolmogorov scaling although a similar scaling region is absent for the velocity field in this low Reynolds number flow. Finally, results concerning the mixing and dispersion of scalars in a jet are shown. Although initially the scalar mixing is strongly dependent on input conditions, the mixing is shown to be rapid and the correlation coefficient asymptotes to unity by $x/D \sim 20$.

7168 (CONF-9305134–, pp. 237-247) **Particle interactions in concentrated suspensions.** Mondy, L.A. (Sandia National Labs., Albuquerque, NM (United States)); Graham, A.L.; Abbott, J.R.; Brenner, H. Argonne National Lab., IL (United States). 1993. DOE Contract W-7405-ENG-36 ; AC04-76DP00789. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

An overview is presented of research that focuses on slow flows of suspensions in which colloidal and inertial effects are negligibly small. The authors describe nuclear magnetic resonance imaging experiments to quantitatively measure particle migration occurring in concentrated suspensions undergoing a flow with a nonuniform shear rate. These experiments address the issue of how the flow field affects the microstructure of suspensions. In order to understand the local viscosity in a suspension with such a flow-induced, spatially varying concentration, one must know how the viscosity of a homogeneous suspension depends on such variables as solids concentration and particle orientation. The authors suggest the technique of falling ball viscometry, using small balls, as a method to determine the effective viscosity of a suspension without affecting the original microstructure significantly. They also describe data from experiments in which the detailed fluctuations of a falling ball's velocity indicate the noncontinuum nature of the suspension and may lead to more insights into the effects of suspension microstructure on macroscopic properties. Finally, they briefly describe other experiments that can be performed in quiescent suspensions (in contrast to the use of conventional shear rotational viscometers) in order to learn more about boundary effects in concentrated suspensions.

7169 (CONF-9305134–, pp. 248-254) **Molecular mixing in turbulent flow.** Kerstein, A.R. (Sandia National Labs., Livermore, CA (United States)). Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The evolution of a diffusive scalar field subject to turbulent stirring is investigated by comparing two new modeling approaches, the linear-eddy model and the clipped-laminar-profile representation, to results previously obtained by direct numerical simulation (DNS) and by mapping-closure analysis. The comparisons indicate

that scalar field evolution is sensitive to the bandwidth of the stirring process, and they suggest that the good agreement between DNS and mapping closure reflects the narrowband character of both. The new models predict qualitatively new behaviors in the wideband stirring regime corresponding to high-Reynolds-number turbulence.

7170 (CONF-9305134–, pp. 255-262) **Ensemble phase averaging for disperse two-phase flows.** Prosperetti, A. (Johns Hopkins Univ., Baltimore, MD (United States)); Zhang, D.Z. Argonne National Lab., IL (United States). 1993. DOE Contract FG02-89ER14043. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The ensemble-averaging methods used in this paper differ from conventional ones in the use of phase averages (in which only configurations such that the point of interest is in a specified phase are considered) and of averages over quantities defined at particle centers. The first feature leads to rigorous equations of motion of the general two-fluid type, and the second one renders a straightforward derivation of the disperse momentum equation possible even in the presence of degenerate constitutive relations for the particle material. The authors present numerous applications of this method to: (i) rigid particles in inviscid incompressible flow; (ii) spherical bubbles in inviscid incompressible flow; (iii) rigid particles in Stokes flow; (iv) heat transfer in high-diffusivity fluids. While most of the results are for the dilute limit, some numerical results for finite volume fractions are presented for the linear problem.

7171 (DOE/ER/13528–7) **Two-phase potential flow: Progress report, July 1, 1992–June 30, 1993.** Wallis, G.B. Dartmouth Coll., Hanover, NH (United States). Thayer School of Engineering. Jul 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER13528. Order Number DE94004172. Source: OSTI; NTIS; GPO Dep.

Progress towards developing a mature science of two-phase potential flow is reported in three areas: Fundamental theorems concerning the properties of dispersed systems; theoretical derivation of these properties; and experimental confirmation. New work is reported on flows with unknown interface geometry, as in gas-liquid flows. The interface shape is predicted as part of the solution.

7172 (DOE/ER/13839–T2) **Comparative study of the vorticity field in turbulent flows: Theory, experiments and computations: Final report.** Hussain, F. Houston Univ., TX (United States). Dept. of Mechanical Engineering. [1991]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-88ER13839. Order Number DE94003320. Source: OSTI; NTIS; GPO Dep.

We have carried out a comprehensive study of unexcited and excited elliptic jets, addressing the effects of initial conditions, aspect ratio, excitation frequency, and excitation amplitude. We have studied the dynamics of the preferred mode structure and interactions of coherent structure in the near field of elliptic jets. The dynamics of elliptic jets are quite different from the extensively studied plane and circular jets – owing mainly to the fact that the azimuthal curvature variation of a vortical structure causes a nonuniform self-induction and hence complex three-dimensional deformation. Such deformation, combined with properly selected excitation, can substantially alter entrainment and other turbulence phenomenon, thus suggesting a preference for the elliptic shape in many jet applications. In the following, we mention a few key results.

7173 (DOE/PC/92152–T4) **The effect of turbulence on the stability of liquid jets and the resulting droplet size distributions: Third quarterly technical report, July 1, 1993–September 30, 1993.** Mansour, A.; Chigier, N. Carnegie-Mellon Univ., Pittsburgh, PA (United States). Dept. of Mechanical Engineering. [1993]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92152. Order Number DE94004522. Source: OSTI; NTIS; GPO Dep.

Laminar and turbulent columns of liquids issuing from capillary tubes were studied in order to determine the effects of turbulence on the stability of liquid jets and to establish the influence of liquid turbulence on droplet size distributions after breakup. Two capillary tubes were chosen with diameters D_1=3.0mm and D_2=1.2mm; jet Reynolds numbers were 1000–30000, and 400–7200. For water injection into stagnant air, stability curve is bounded by a laminar portion, where a jet radius and δ_o initial disturbance amplitude, and a fully developed turbulent portion characterized by high initial disturbance amplitude ($\ln(a/\delta_{o,T}) \sim 4.85$). In the transition region, $\ln(a/\delta_o)$ is not single valued; it decreases with increasing Reynolds number. In absence of aerodynamic effects, turbulent jets are as stable as laminar jets. For this breakup mode turbulence propagates initial disturbances with amplitudes orders of magnitude larger than laminar jets ($\delta_{o,T}=28\times10^6\ \delta_{o,L}$). Growth rates of initial disturbances are same for both laminar and turbulent columns with theoretical Weber values. Droplet size distribution is bi-modal; the number ratio of large (> D/2), to small (< D/2) droplets is 3 and independent of Reynolds number. For laminar flow optimum wavelength (λ_{opt}) corresponding to fastest growing disturbance is equal to 4.45D, exactly the theoretical Weber value. For turbulent flow conditions, the turbulent column segments. Typically, segments with lengths of one to several wavelengths, detach from the liquid jet. The long ligaments contract under the action of surface tension, resulting in droplet sizes larger than predicted by Rayleigh and Weber. For turbulent flow conditions, λ_{opt} = 9.2D, about 2 times the optimum Weber wavelength.

7174 (DOE/PN/38195–T1) **Large scale steam flow test: Pressure drop data and calculated pressure loss coefficients.** Meadows, J.B. (Bettis Atomic Power Lab., Pittsburgh, PA (United States)); Spears, J.R.; Feder, A.R.; Moore, B.P.; Young, C.E. Newport News Shipbuilding, VA (United States); Bettis Atomic Power Lab., Pittsburgh, PA (United States). Dec 1993. 404p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. Contract 73-R-N140302-S. Order Number DE94004430. Source: OSTI; NTIS; INIS; GPO Dep.

This report presents the result of large scale steam flow testing, 3 million to 7 million lbs/hr., conducted at approximate steam qualities of 25, 45, 70 and 100 percent (dry, saturated). It is concluded from the test data that reasonable estimates of piping component pressure loss coefficients for single phase flow in complex piping geometries can be calculated using available engineering literature. This includes the effects of nearby upstream and downstream components, compressibility, and internal obstructions, such as splitters, and ladder rungs on individual piping components. Despite expected uncertainties in the data resulting from the complexity of the piping geometry and two-phase flow, the test data support the conclusion that the predicted dry steam K-factors are accurate and provide useful insight into the effect of entrained liquid on the flow resistance. The K-factors calculated from the wet steam test data were compared to two-phase K-factors based on the Martinelli-Nelson pressure drop correlations. This comparison supports the concept of a two-phase multiplier for estimating the resistance of piping with liquid entrained into the flow. The test data in general appears to be reasonably consistent with the shape of a curve based on the Martinelli-Nelson correlation over the tested range of steam quality.

7175 (DTH-ISVA-PR–73) **Progress report no. 73.** Geoteknisk Inst., Lyngby (Denmark). Dec 1991. 66p. Order Number DE94730211. Source: OSTI; NTIS.

The Progress Report no.73 of the Danish Institute of Hydrodynamics and Hydraulic Engineering consists of 5 contributions on bed wave shape, shear stress in surf zone, diffusion in suspended sediments etc. (EG)

7176 (DTH-ISVA-PR–73, pp. 31-53) **A stochastic model for two-phase flow in heterogeneous porous media.** Butts, M.B. (Inst. Hydrodyn. and Hydraulic Eng., Tech. Univ. (Denmark)). Geoteknisk Inst., Lyngby (Denmark). 1991. In *Progress report no. 73.* 66p. Order Number DE94730211. Source: OSTI; NTIS.

A stochastic framework for the analysis of two-phase flow in heterogeneous porous media is presented. The study is motivated by the need to model multiphase flow in natural soil and rock formations where the hydraulic properties exhibit significant spatial

variations. Large-scale two-phase flow equations are derived by averaging the local flow equations, assuming the variation of the local soil properties can be represented by stationary random fields. The resulting mean flow equations have the same form as the local equations where effective (large-scale) flow parameters now appear. General expressions for these effective parameters are derived from a quasi-linearised perturbation equation and a spectral representation of the underlying random fields. Formal solutions for the resulting equations are also presented. This initial analysis reveals large-scale hysteresis of the effective parameters in two-phase flow. This effect occurs solely as a result of the variability of the soil properties. (au)

7177 (KFK–5120) **Solution methods for large systems of linear equations in BACCHUS.** Homann, C.; Dorr, B. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Reaktorsicherheit; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Nukleare Sicherheitsforschung. May 1993. 65p. Order Number DE94734060. Source: OSTI; NTIS (US Sales Only); INIS.

The computer programme BACCHUS is used to describe steady state and transient thermal-hydraulic behaviour of a coolant in a fuel element with intact geometry in a fast breeder reactor. In such computer programmes generally large systems of linear equations with sparse matrices of coefficients, resulting from discretization of coolant conservation equations, must be solved thousands of times giving rise to large demands of main storage and CPU time. Direct and iterative solution methods of the systems of linear equations, available in BACCHUS, are described, giving theoretical details and experience with their use in the programme. Besides use of a method of lines, a Runge-Kutta-method, for solution of the partial differential equation is outlined. (orig.)

7178 (LA–12552-MS) **Modeling turbulence in flows with a strong rotational component.** Burgess, D.E.; O'Rourke, P.J. Los Alamos National Lab., NM (United States). Nov 1993. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003577. Source: OSTI; NTIS; GPO Dep.

We consider the effectiveness of various turbulence models in flows with a strong rotational component. To evaluate the models, we implement them into a one-dimensional test code and make comparisons with experimental data for swirling flow in a cylinder. The K - ϵ type turbulence models do poorly in predicting the experimental results. However, we find that the incorporation of a Reynolds stress evolution equation gives good agreement with the experimentally measured mean flow. Modeling the pressure-strain correlation tensor correctly is the key for obtaining good results. A combination of Launder's basic model together with Yakhot's dissipation rate equation [3] works best in predicting both the mean flow and the turbulence intensity.

7179 (LBL–34124-Rev.) **Vortex methods.** Chorin, A.J. (California Univ., Berkeley, CA (United States). Dept. of Mathematics). Lawrence Berkeley Lab., CA (United States). Jun 1993. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9306196–1-Rev.: Les Houches Summer School of Theoretical Physics, Les Houches (France), 28 Jun - 30 jul 1993). Order Number DE94003245. Source: OSTI; NTIS; GPO Dep.

Vortex methods originated from the observation that in incompressible inviscid flow vorticity (or, more accurately, circulation) is a conserved quantity, as can be readily deduced from the absence of tangential stresses. Thus, if the vorticity is known at time t=0, one can find the flow at a later time by simply following the vorticity. In this narrow context, a vortex method is a numerical method that follows vorticity. The author restricts himself in these lectures to a special class of numerical vortex methods, those that are based on a Lagrangian transport of vorticity in hydrodynamics by smoothed particles (blobs) and those whose analysis contributes to the understanding of blob methods. Blob methods started in the 1930's.

7180 (TRITA-MEK-TR–93-10) **On the deterministic and chaotic flow in a thermal convection loop.** Fiedler, G. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Mechanics. Sep 1993. 75p. Order Number DE94730445. Source: OSTI; NTIS.

The fractal dimension and Lyapunov exponent are measured for the chaotic flow in a thermal convection loop. With a one dimensional map of the flow, it is demonstrated that the dynamics of the thermosyphon is similar to that of an NH_3 ring laser. Various characteristics of the thermosyphon are measured, such as temperature and frequencies of the flow versus heating. Attempts to stabilize the no-motion state with a feedback controller is described, and the effect of time delay in the controller is analyzed. 32 refs, 69 figs

7181 (UCRL-ID–114570) **Modeling of pulverulent ceramic jets with CALE: Final report.** Winer, K.; Maxwell, D. Lawrence Livermore National Lab., CA (United States). 31 Dec 1992. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94005314. Source: OSTI; NTIS; GPO Dep.

The intent of this work is to provide an accurate, predictive description of the formation and evolution of pulverulent (consisting of finely divided grains) ceramic jets. The present phase of this effort is devoted to validation and optimization of the intact and powder ceramic material models by comparison of calculated model performance with experimental data. Physically reasonable parameters were chosen for the model which was optimized by comparison of the calculated results with experimental flash X-ray density data. Optimization parameters included jet tip velocity, jet density distributions, jet radius, and penetration depth. The optimized jets were tested in configurations similar to those of experiment and reproduced the data adequately. Jet formation from intact ceramic liners is a complicated physical process which is not yet completely understood. Models have been developed to describe this process at the level of current understanding. The models account for such processes as fracture of the solid ceramic by the high explosive detonation shock front, loss of yield strength as the resulting pulverized ceramic is decompressed and flows into the jet, dilatation and expansion of the pulverized ceramic as jet formation proceeds, and entrainment of air into the voids between the grains of the pulverized ceramic as the jet stretches and expands. The description of the behavior of ceramics under shock loading consists of four models (equation of state model, dilatancy model, air diffusion model, and strength model) which are incorporated into a special version of LLNL's CALE, a C-language-based, two-dimensional Arbitrary Lagrangian-Eulerian hydrocode that is portable to Unix systems. Despite the interdependence of the model components, it is possible to determine reasonable values for the model parameters which allow quantitative agreement with the existing experimental data. These are briefly described and compared to the results of CALE simulations.

4205 Materials Testing

Refer also to citation(s) 6228, 6951, 6952, 6953, 6986, 7000, 7015, 7016, 7086, 7087, 7105, 7357, 7958

7182 (CONF-9305134–, pp. 77-84) **Potential drop crack growth monitoring in high temperature biaxial fatigue tests.** Fitzgerald, B.P. (Rensselaer Polytechnic Institute, Troy, NY (United States)); Krempl, E. Argonne National Lab., IL (United States). 1993. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

The present work describes a procedure for monitoring crack growth in high temperature, biaxial, low cycle fatigue tests. The reversing DC potential drop equipment monitors smooth, tubular type 304 stainless steel specimens during fatigue testing. Electrical interference from an induction heater is filtered out by an analog filter and by using a long integration time. A Fourier smoothing algorithm and two spline interpolations process the large data set. The experimentally determined electrical potential drop is compared with the theoretical electrostatic potential that is found by solving Laplace's equation for an elliptical crack in a semi-infinite conducting medium. Since agreement between theory and experiment is good, the method can be used to measure crack growth to failure from the threshold of detectability.

7183 (SAND–93-1076) **Standard testing procedures for optical fiber and unshielded twisted pair at Sandia National Laboratories.** Adams, R.L. Sandia National Labs., Albuquerque, NM (United States). Nov 1993. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94005315. Source: OSTI; NTIS; GPO Dep.

This document will establish a working standard for testing optical fiber and unshielded twisted pair cables included in the Lab-wide telecommunications cabling system. The purpose of these standard testing procedures is to deliver to all Sandians a reliable, low-maintenance, state-of-the-art, ubiquitous telecommunications cabling infrastructure capable of satisfying all current and future telecommunication needs.

7184 (WAPD-T–2947) **The qualification of NDT inspection personnel in the naval nuclear propulsion program.** Nance, R.A. Bettis Atomic Power Lab., West Mifflin, PA (United States). [1990]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-901053–5: Fall conference of the American Society for Nondestructive Testing, Seattle, WA (United States), 9-12 Oct 1990). Order Number DE94004023. Source: OSTI; NTIS; GPO Dep.

As the U.S. Navy entered the age of nuclear propulsion it realized that the safety requirements necessary to protect the lives of naval personnel on board nuclear powered vessels, as well as protecting the civilian Population, required a higher quality of (non-destructive testing) NDT inspection than was currently available in industry. As a result, the Naval Reactors (NR) office established an NDT qualification program under the jurisdiction of the Naval Sea Systems Command Technical Representative (NSTR) located in Pittsburgh, PA. The Bettis Laboratory (a prime contractor laboratory operated for the government by Westinghouse Electric Corporation) was given the lead in developing and administering the resulting qualification program. Each facility, whether military or civilian, that is engaged in applicable NDT inspections in the Naval Nuclear Propulsion Program (NNPP) is required to send representatives to the Bettis Laboratory where they take qualification examinations, the passing of which certifies them as NDT Examiners. They are then responsible for qualifying and monitoring those inspection personnel at their facility who are performing NDT inspections. This paper discusses the mechanics and philosophy of this program.

4210 Combustion Systems

Refer also to citation(s) 7916

4220 Mining and Underground Engineering

7185 (SAND–93-1953) **Program plan for the development of advanced synthetic-diamond drill bits for hard-rock drilling.** Glowka, D.A.; Schafer, D.M. Sandia National Labs., Albuquerque, NM (United States). Sep 1993. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94003137. Source: OSTI; NTIS; GPO Dep.

Eight companys have teamed with Sandia Labs to work on five projects as part of a cooperative effort to advance the state of the ar in synthetic-diamond drill bit design and manufacture. DBS (a Baroid Company), Dennis Tool Company, Hughes Christensen Company, Maurer Engineering, Megadiamond, Security Diamond Products, Slimdril International, and Smith International. Objective of each project is to develop advanced bit technology that results in new commercial products with longer bit life and higher penetration rates in hard formations. Each project explores a different approach to synthetic-diamond cutter and bit design and, consequently, uses different approaches to developing the technology. Each of these approaches builds or the respective companies' capabilities and current product interests. Sandia's role is to assure integration of the individual projects into a coherent program and tc provide unique testing and analytical capabilities where needed. One additional company, Amoco Production Research, will provide synthetic-diamond drill bit research expertise and field testing services for each project in the program.

4230 Marine Engineering

Refer also to citation(s) 6083

7186 (WAPD-T–2956) **An improvement in the modified finite element procedure for underwater shock analysis.** Chan, S.K. Bettis Atomic Power Lab., West Mifflin, PA (United States). [1992]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-9210176–6: 63. shock and vibration symposium, Las Cruces, NM (United States), 27 Oct 1992). Order Number DE94004451. Source: OSTI; NTIS; GPO Dep.

The modified finite element procedure for underwater shock analysis decomposes the total pressure field into the incident, reflected and radiated pressure. The incident pressure is calculated by using a closed form solution. The reflected and radiated pressure are calculated in two separate finite element analyses. Artificial damping is added in the finite element analyses. Since these two pressures are generated from the fluid-structure interface and mostly propagate away from the interface, the artificial damping has no significant effect on the result. The modified finite element procedure was developed using a displacement formulated finite element to model the fluid region. In the paper, a pressure formulated finite element is used to model the fluid region which has a potential of saving 90 percent of the computer time. In doing so, the reflected and radiated pressure are calculated in one analysis which greatly simplifies the analysis procedure and saves more computer time. Two verification examples are given.

4250 Power Cycles

Refer also to citation(s) 6896

7187 (LUTMDN-TMVK–5221) **Comparison between the combined cycle and the HAT cycle.** Oest, H. Lund Univ. (Sweden). Dept. of Heat and Power Engineering. Aug 1993. 42p. Order Number DE94730414. Source: OSTI; NTIS.

Examination paper.

In this report the combined cycle and the HAT cycle have been compared systematically using the same assumptions in both cycle calculations. The study is mainly based on a parametric study of the two cycles which was done by the author for this purpose. The parametric study of the combined cycle and the HAT cycle are done in separate chapters where the methods of calculation as well as boundary conditions and assumptions are described. The results from the calculation are then presented in diagrams and commented. Finally, a comparison is done of the two cycles. The final results show that the combined cycle is the better cycle in this study mainly because it has the highest efficiency. 5 refs, 17 figs, 4 tabs

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 6122, 6123, 6582, 6999, 7073, 7075, 7076, 7078, 7125, 7210, 7778, 7779, 7780, 7942

7188 (CONF-9011127–20-Vugraphs) **Novel methods of copper vapor laser excitation.** McColl, W.B. (Michigan Univ., Ann Arbor, MI (United States)); Ching, H.; Bosch, R.; Brake, M.; Gilgenbach, R. Michigan Univ., Ann Arbor, MI (United States); Lawrence Livermore National Lab., CA (United States). [1990]. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER12891 ; W-7405-ENG-48. From 32. annual meeting of the American Physical Society - Division of Plasma Physics (APS/DPP); Cincinnati, OH (United States); 12-16 Nov 1990. Order Number DE94004849. Source: OSTI; NTIS; INIS; GPO Dep.

Microwave and intense electron beam excitation of copper vapor are being investigated to be used in copper vapor lasers for isotope separation. Both methods use copper chloride vapor by heating copper chloride. Helium was used as the buffer gas at 2 to 100 torr. In the microwave system, intense copperlines at 510 nm and 578 nm were observed. Initial electron beam results indicate that light emission follows the beam current.

7189 (DOE/ER/12891–3) **Electron density and collision frequency of microwave resonant cavity produced discharges:**

[Progress report]. McColl, W.; Brooks, C.; Brake, M.L. Michigan Univ., Ann Arbor, MI (United States). Dept. of Nuclear Engineering. [1992]. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER12891. Order Number DE94004844. Source: OSTI; NTIS; INIS; GPO Dep.

This progress report consists of an article, the abstract of which follows, and apparently the references and vita from a proposal. A review of perturbation diagnostics applied to microwave resonant cavity discharges is presented. The classical microwave perturbation technique examines the shift in the resonant frequency and cavity quality factor of the resonant cavity caused by low electron density discharges. However, modifications presented here allow the analysis to be applied to discharges with electron densities beyond the limit predicted by perturbation theory. An 'exact' perturbation analysis is presented which models the discharge as a separate dielectric, thereby removing the restrictions on electron density imposed by the classical technique. The 'exact' method also uses measurements of the shifts in the resonant conditions of the cavity. Thirdly, an electromagnetic analysis is presented which uses a characteristic equation, based upon Maxwell's laws, and predicts the discharge conductivity based upon measurements of a complex axial wave number. By allowing the axial wave number of the electromagnetic fields to be complex, the fields are experimentally and theoretically shown to be spatially attenuated. The diagnostics are applied to continuous-wave microwave (2.45 GHz) discharges produced in an Asmussen resonant cavity. Double Langmuir probes, placed directly in the discharge at the point where the radial electric field is zero, act as a comparison with the analytic diagnostics. Microwave powers ranging from 30 to 100 watts produce helium and nitrogen discharges with pressures ranging from 0.5 to 6 torr. Analysis of the data predicts electron temperatures from 5 to 20 eV, electron densities from 10^{11} to 3×10^{12} cm^{-3}, and collision frequencies from 10^{9} to 10^{11} sec^{-1}.

7190 (LBL–33594) **A fully integrated 16 channel digitally trimmed pulse shaping amplifier.** Hearn, W.E.; Wright, M.E. Lawrence Berkeley Lab., CA (United States). Nov 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-931107–25: 1993 IEEE nuclear science symposium and medical imaging conference; Institute of Electrical and Electronic Engineers (IEEE) medical imaging conference, San Francisco, CA (United States); San Francisco, CA (United States), 2-5 Nov 1993; 4 Order Number DE94004555. Source: OSTI; NTIS; INIS; GPO Dep.

A fully integrated CMOS pulse shaping amplifier has been developed at LBL. All frequency dependent networks are included on the chip. Provision is made for tuning to compensate for process variations. The overall architecture and details of the circuitry are discussed. Test results are presented.

7191 (LBL–34433) **Instantaneous amplitude and frequency dynamics of coherent wave mixing in semiconductor quantum wells.** Chemla, D.S. Lawrence Berkeley Lab., CA (United States). 30 Jun 1993. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9307155–1: International school of physices on enrice fermi, Varenna (Italy), 20-30 Jul 1993). Order Number DE94003262. Source: OSTI; NTIS; INIS; GPO Dep.

This article reviews recent investigations of nonlinear optical processes in semiconductors. Section II discusses theory of coherent wave mixing in semiconductors, with emphasis on resonant excitation with only one exciton state. Section III reviews recent experimental investigations of amplitude and phase of coherent wave-mixing resonant with quasi-2d excitons in GaAs quantum wells.

7192 Electrochemical thinning of silicon. Medernach, J.W. To Dept. of Energy. 1991. U.S. patent application 7-798,781. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE94005173. Source: OSTI; NTIS; GPO Dep.

Porous semiconducting material, e.g. silicon, is formed by electrochemical treatment of a specimen in hydrofluoric acid, using the specimen as anode. Before the treatment, the specimen can be masked. The porous material is then etched with a caustic solution or is oxidized, depending of the kind of structure desired, e.g. a thinned specimen, a specimen, a patterned thinned specimen, a specimen with insulated electrical conduits, and so on. Thinned silicon specimen can be subjected to tests, such as measurement of interstitial oxygen by Fourier transform infra-red spectroscopy (FTIR).

7193 (SAND–93-1323C) **Advanced qualification techniques.** Winokur, P.S; Shaneyfelt, M.R.; Meisenheimer, T.L.; Fleetwood, D.M. Sandia National Labs., Albuquerque, NM (United States). [1993]. 11p. Sponsored by Defense Nuclear Agency, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-930953–2: 2. European conference on radiations and their effects on devices and systems, Saint Malo (France), 13-16 Sep 1993). Order Number DE94003709. Source: OSTI; NTIS; INIS; GPO Dep.

This paper demonstrates use of the Qualified Manufacturers List (QML) methodology to qualify commercial and military microelectronics for use in space applications. QML "builds in" the hardness of product through statistical process control (SPC) of technology parameters relevant to the radiation response, test structure to integrated circuit (IC) correlations, and techniques for extrapolating laboratory test results to low-dose-rate space scenarios. Each of these elements is demonstrated and shown to be a cost-effective alternative to expensive end-of-line IC testing. Several examples of test structured-IC correlations are provided and recent work on complications arising from transistor scaling and geometry is discussed. The use of a 10-keV x-ray wafer-level test system to support SPC and establish "process capability" is illustrated and a comparison of 10-keV x-ray and Co^{60} gamma irradiations is provided for a wide range of CMOS technologies. The x-ray tester is shown to be cost-effective and its use in lot acceptance/qualification is recommended. Finally, a comparison is provided between MIL-STD-883D, Test Method 1019.4, which governs the testing of packaged semiconductor microcircuits in the DoD, and ESA/SSC Basic Specification No. 22900, Europe's Total Dose Steady-State Irradiation Test Method. Test Method 1019.4 focuses on conservative estimates of MOS hardness for space and tactical applications, while Basic Specification 22900 focuses on improved simulation of low-dose-rate space environments.

7194 (SAND–93-1509C) **Thermally stable oxygen and nitrogen implant isolation of C-doped $Al_{0.35}Ga_{0.65}As$.** Zolper, J.C.; Sherwin, M.E.; Baca, A.G.; Schneider, R.P. Jr. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931108–28: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004799. Source: OSTI; NTIS; GPO Dep.

Oxygen and nitrogen ion implantation have been applied to C-doped $Al_{0.35}Ga_{0.65}As$ layers to produce high resistivity regions ($\rho_s \geq 1 \times 10^{10}$ Ω/□ that are stable after annealing at 900C. A dose threshold for stable compensation for both O and N ions was found above 8×10^{13} cm^{-2} for samples doped at 2×10^{18} cm^{-3}. Although O implantation has been reported to form stable compensation in Si-doped and Be-doped AlGaAs, the ability of nitrogen implantation to produce thermally stable compensation has not been previously reported and may be due to a C-N complex. The existence of this C-N complex is supported by results for O- and N-implants into C-doped GaAs where N formed thermally stable compensation but O did not. Sheet resistance data versus anneal temperature and estimates of the depth of the defect levels are reported. This result will have application to hetcrojunction bipolar transistors and complementary heterostructure field effect transistor technologies that employ C-doped AlGaAs or GaAs layers along with high temperature post-isolation processing.

7195 (SAND–93-1870C) **Effects of oxide charge and surface recombination velocity on the excess base current of BJTs.** Kosier, S.L. (Univ. of Arizona, Tucson, AZ (United States)); Schrimpf, R.D.; Wei, A.; DeLaus, M.; Fleetwood, D.M.; Combs, W.E. Sandia National Labs., Albuquerque, NM (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States);Defense Nuclear Agency, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9310238–1: Institute of

Electrical and Electronics Engineers (IEEE) bipolar/BiCMOS circuits and technology meeting, Minneapolis, MN (United States), 4-5 Oct 1993). Order Number DE94003711. Source: OSTI; NTIS; GPO Dep.

The role of net positive oxide trapped charge and surface recombination velocity on excess base current in BJTs is identified. The effects of the two types of damage can be detected by plotting the excess base current versus base-emitter voltage. Differences and similarities between ionizing-radiation-induced and hot electron-induced degradation are discussed.

7196 (UCRL-JC–115682) **Observation of stimulated emission from an MBE grown GaN film on sapphire.** Yung, K. (Lawrence Livermore National Lab., CA (United States)); Yee, J.; Koo, J.; Rubin, M.; Newman, N.; Fu, T.; Ross, J. Lawrence Livermore National Lab., CA (United States). 12 Nov 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9311138–1: NOVEL laser sources and applications workshop, San Jose, CA (United States), 12-13 Nov 1993). Order Number DE94003638. Source: OSTI; NTIS; GPO Dep.

The authors report the first observation of optically pumped stimulated emission from an GaN epilayer at 77K and at room temperature grown by reactive ion-beam molecular beam epitaxy. The observed uv optical emission profile was a nonlinear function of the pump power density, with line narrowing at threshold power densities. The similarity in the emission profile as compared with those of films grown with low-pressure metal-organic chemical vapor deposition and metal-organic vapor phase epitaxy techniques will be noted.

43 PARTICLE ACCELERATORS

Refer also to citation(s) 7508, 7509

7197 (DOE/ER/40374–73) **Research in accelerator physics (theory): Progress report, May 15, 1993–October 31, 1993.** Ohnuma, Shoroku. Houston Univ., TX (United States). Dept. of Physics. 1 Nov 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-87ER40374. Order Number DE94005162. Source: OSTI; NTIS; INIS; GPO Dep.

The authors discuss the present status, expected effort during the remainder of the project, and some of the results of their activities since the beginning of the project. Some of the areas covered are: (1) effects of helical insertial devices on beam dynamics; (2) coupling impedance of apertures in accelerator beam pipes; (3) new calculation of diffusion rate; (4) integrable polynomial factorization for symplectic map tracking; and (5) physics of magnet sorting in superconducting rings.

4301 Design, Development, and Operation

Refer also to citation(s) 6172, 6175, 7327, 7328, 7491, 7566, 7713, 7886, 7887

7198 (ANL/ASD/CP–81301) **A 50-MeV mm-wave electron linear accelerator system for production of tunable short wavelength synchrotron radiation.** Nassiri, A. (Argonne National Lab., IL (United States). Advanced Photon Source Accelerator Systems Div.); Kustom, R.L.; Mills, F.E.; Kang, Y.W.; Matthews, P.J.; Grudzien, D.; Song, J.; Horan, D.; Feinerman, A.D.; Willke, T.L. Argonne National Lab., IL (United States). Advanced Photon Source Accelerator Systems Div. [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931215–3: International electron devices meeting, Washington, DC (United States), 5-8 Dec 1993). Order Number DE94004574. Source: OSTI; NTIS; INIS; GPO Dep.

The Advanced Photon Source (APS) at Argonne in collaboration with the University of Illinois at Chicago and the University of Wisconsin at Madison is developing a new millimeter wavelength, 50-MeV electron linear accelerator system for production of coherent tunable wavelength synchrotron radiation. Modern micromachining techniques based on deep etch x-ray lithography, LIGA (Lithografie, Galvanoformung, Abformung), capable of producing high-aspect ratio structures are being considered for the fabrication of the accelerating components.

7199 (BNL–49214-Rev.(12/3/93)) **National Synchrotron Light Source operations policies, operational safety limits and policy upgrades: Revision.** Batchelor, K. Brookhaven National Lab., Upton, NY (United States). 3 Dec 1993. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE94005509. Source: OSTI; NTIS; GPO Dep.

The National Synchrotron Light Source Safety Analysis Reports (1),(2),(3), BNL reports #51584, #52205 and #52205 (addendum) describe the basic Environmental Safety and Health issues associated with the department's operations. They include the operating envelope for the Storage Rings and also the rest of the facility. These documents contain the operational limits as perceived prior or during construction of the facility, much of which still are appropriate for current operations. However, as the machine has matured, the experimental program has grown in size, requiring more supervision in that area. Also, machine studies have either verified or modified our knowledge of beam loss modes and/or radiation loss patterns around the facility. This document is written to allow for these changes in procedure or standards resulting from their current mode of operation and shall be used in conjunction with the above reports. These changes have been reviewed by NSLS and BNL ES&H committees and approved by BNL management.

7200 (DOE/FTR–94002468) **Travel to Switzerland to confer with colleagues in the CERN Computing and Networks Division: Foreign trip report, March 8–16, 1991.** Marraffino, J. Fermi National Accelerator Lab., Batavia, IL (United States). 23 Mar 1991. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE94002468. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The main purpose of this trip to Geneva was to exchange information with a number of colleagues in the Computing Division at CERN. The areas of particular interest included the direction in which they plan to develop their graphics applications in the future and the overall computing environment which define the context of those developments. Additionally, several people at CERN had expressed an interest in the details of the Fermilab experience with X terminals. They are just now coming to grips with this new technology and are attempting to determine how to integrate it into their planning.

7201 (DOE/IG–0336) **Audit of controls over Superconducting Super Collider Laboratory subcontractor expenditures.** USDOE Office of Inspector General, Washington, DC (United States). Capital Regional Audit Office. 22 Oct 1993. 43p. Sponsored by USDOE, Washington, DC (United States). Source: OSTI (Free of Charge).

Report to The Secretary.

In January 1989 the Department of Energy contracted with Universities Research Association, Inc. to design, construct, manage, operate, and maintain the Superconducting Super Collider Laboratory. Through Fiscal Year 1992, costs for subcontractor goods and services accounted for about 75 percent of the Superconducting Super Collider Laboratory expenditures. The Office of Inspector General evaluated the adequacy of controls in place to ensure that subcontractor costs were reasonable, as required by the contract. The following conclusions were drawn from the audit. The Superconducting Super Collider Laboratory did not consistently exercise prudent business judgment in making subcontractor expenditures. As a result, $60 million in expenditures already made and $128 million planned with commercial subcontractors were, in the authors opinion, unnecessary, excessive, or represented uncontrolled growth. The audit also found inadequate justifications, accountability, and cost controls over $143 million in expenditures made and $47 million planned with other Department of Energy laboratories. Improvements were needed in subcontract administration and internal controls, including appropriate audit coverage of the subcontracts. In addition, Department of Energy guidance concerning procurement actions between the laboratories needed to be established.

7202 (LBL–34722) **Technical design of hadron therapy facilities.** Alonso, J.R. Lawrence Berkeley Lab., CA (United States). Aug 1993. 16p. Sponsored by Department of Health and Human Services, Washington, DC (United States). DOE Contract AC03-76SF00098. Grant CA 56932. (CONF-9308168–4: International seminar on planetary emergencies; NATO workshop on global stability through disarmament, Erice (Italy); Erice (Italy), 19-24 Aug 1993; 19-23 aug 1993; CONF-9308195–1). Order Number DE94004556. Source: OSTI; NTIS; INIS; GPO Dep.

Radiation therapy with hadron beams now has a 40-year track record at many accelerator laboratories around the world, essentially all of these originally physics-research oriented. The great promise shown for treating cancer has led the medical community to seek dedicated accelerator facilities in a hospital setting, where more rapid progress can be made in clinical research. This paper will discuss accelerator and beam characteristics relevant to hadron therapy, particularly as applied to hospital-based facilities. A survey of currently-operating and planned hadron therapy facilities will be given, with particular emphasis on Loma Linda (the first dedicated proton facility in a hospital) and HIMAC (the first dedicated heavy-ion medical facility).

7203 (LBL–34736) **Fifth Annual Meeting of the Advanced Light Source User's Association.** Lawrence Berkeley Lab., CA (United States). Oct 1993. 165p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9208225–: Advanced light source users meeting, Berkeley, CA (United States), 27-28 Aug 1992). Order Number DE94003476. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the following topics: ALS Project Status; Accelerator Commissioning; Experimental Systems: Supersmooth Optics and Ultra-Precise Undulators; Planning for Users and User Services; ALS Scientific Program; High Resolution Core-Level Photoemission; Photoelectron Diffraction and Holography; Soft X-Ray Emission Spectroscopy of Solids at the NSLS and the ALS; Gas-Phase Spectrometry; Spectromicroscopy; X-Ray Dichroism Experiments Using Circular Polarization; Magnetic Circular X-Ray Dichroism and MCXD Microscopy; Applications of Soft X-Ray Optics to Sub-Micron Silicon Device Technology; Bend Magnet Microprobe; Protein Crystallography: Recent Developments and Plans for the ALS; and Applications of High-Brightness Synchrotron Radiation to Protein Crystallography.

7204 (LBL–34837) **A theory of two-beam acceleration of charged particles in a plasma waveguide.** Ostrovsky, A.O. (Kharkov Inst. of Physics and Technology (Ukraine)). Lawrence Berkeley Lab., CA (United States). Nov 1993. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94004938. Source: OSTI; NTIS; INIS; GPO Dep.

The progress made in recent years in the field of high-current relativistic electron beam (REB) generation has aroused a considerable interest in studying REB potentialities for charged particle acceleration with a high acceleration rate T = 100MeV/m. It was proposed, in particular, to employ high-current REB in two-beam acceleration schemes (TBA). In these schemes high current REB (driving beam) excites intense electromagnetic waves in the electrodynamic structure which, in their turn, accelerate particles of the other beam (driven beam). The TBA schemes can be divided into two groups. The first group includes the schemes, where the two beams (driving and driven) propagate in different electrodynamic structures coupled with each other through the waveguides which ensure the microwave power transmission to accelerate driven beam particles. The second group includes the TBA schemes, where the driving and driven beams propagate in one electrodynamic structure. The main aim of this work is to demonstrate by theory the possibility of realizing effectively the TBA scheme in the plasma waveguide. The physical model of the TBA scheme under study is formulated. A set of equations describing the excitation of RF fields by a high-current REB and the acceleration of driven beam electrons is also derived. Results are presented on the the linear theory of plasma wave amplification by the driving beam. The range of system parameters, at which the plasma-beam instability develops, is defined. Results of numerical simulation of the TBA scheme under study are also presented. The same section gives the description of the dynamics of accelerated particle bunching in the high-current REB-excited field. Estimates are given for the accelerating field intensities in the plasma and electron acceleration rates.

7205 (SAND–93-1358) **Performance of an induction coil gun.** Shokair, I.R.; Cowan, M.; Kaye, R.J.; Marder, B.M. Sandia National Labs., Albuquerque, NM (United States). Oct 1993. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94003673. Source: OSTI; NTIS; GPO Dep.

Performance of an electromagnetic induction launcher is considered for three types of armatures. These are: Solid, 1-element wound and 16-element wound aluminum ar natures. The one element wound armature has uniform current density throughout. Because of the radial distribution of the current density, the wound armature can withstand field reversal (working against embedded flux in the armature) and still maintain low temperature. Slingshot simulations were performed, for several configurations. Best performance was obtained for a single element wound armature with two field reversals. For a 60 kg projectile, 10.5 cm coil inner radius and 5.5 cm coil build, the velocity after 50 meters of launcher length (670 stages) exceeded 3.5 km/sec with an overall efficiency of about 45%. For the same parameters the solid and 16-element wound armatures reach a velocity of about 3.3 km/sec after 800 stages (60 meters of launcher length) but without field reversal. A velocity of 3.5 km/sec is possible after 60 meters of launcher length with the 16-element wound armature with one field reversal, but the temperature is close to the melting temperature of aluminum. In all simulations with a solid armature, melting of some of the surface material occurs. However, it is shown that most of the melting occurs after contribution has been made to the forward going pressure, that is, melting does not affect the electrical performance of the launcher. The effect of coil firing tune jitter on launcher performance is also considered and is found to be very small for realistic perturbations. For ± 2 μ-secs random jitter, the reduction in the final velocity for a 60 meter launcher with a solid armature is less than 0.1% and the increase in temperature is only 2%. This result holds for all types of armatures.

7206 (SLAC-PUB–5843) **IR mechanical design B factories.** Bowden, G. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1992. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9204126–21: B factories: state of the art in accelerators, detectors, and physics, Stanford, CA (United States), 6-10 Apr 1992). Order Number DE94003462. Source: OSTI; NTIS; INIS; GPO Dep.

Bringing e^+e^- beams of unequal energy to collision inside a detector for the study of B mesons presents new problems of mechanical support, alignment, magnet design and vacuum engineering.

7207 (SLAC-PUB–6127) **Status of the Stanford Linear Collider.** Seeman, J.T. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Apr 1993. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9207224–2: European Community for Future Accelerators (ECFA) workshop on e+)e(sup− linear colliders (LC92), Garmisch-Partenkirchen (Germany), 25 Jul - 2 aug 1992). Order Number DE94005242. Source: OSTI; NTIS; INIS; GPO Dep.

The Stanford Linear Collider (SLC) was built to collide single bunches of electrons and positrons head-on at a single interaction point with single beam energies up to 55 GeV. The small beam sizes and high currents required for high luminosity operation have significantly pushed traditional beam quality limits. The Polarized Electron Source produces about 8×10^{10} electrons in each of two bunches with up to 28% polarization. The Damping Rings provide coupled invariant emittances of 1.8×10^{-5} r-m with 4.5×10^{10} particles per bunch. The 57 GeV Linac has successfully accelerated over 3×10^{10} particles with design invariant emittances of 3×10^{-5} r-m. Both longitudinal and transverse wakefields affect strongly the trajectory and emittance corrections used for operations. The Arc systems routinely transport decoupled and betatron matched beams. In the Final Focus, the beams are chromatically corrected and demagnified producing spot sizes of 1.7 to 2.2 μm at the focal point. Spot sizes below 1.7 μm have been made during

special tests. Instrumentation and feedback systems are well advanced, providing continuous beam monitoring and pulse-by-pulse control. A luminosity of 2.3 x 10^{29} $cm^{-2}sec^{-1}$ has been produced. Over 11,000 polarized Zs were recorded in the SLD detector in the 1992 physics run.

7208 (SLAC-PUB–6159) **Machine Protection System algorithm compiler and simulator.** White, G.R.; Sherwin, G. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Apr 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930511–503: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94005240. Source: OSTI; NTIS; INIS; GPO Dep.

The Machine Protection System (MPS) component of the SLC's beam selection system, in which integrated current is continuously monitored and limited to safe levels through careful selection and feedback of the beam repetition rate, is described elsewhere in these proceedings. The novel decision making mechanism by which that system can evaluate "safe levels," and choose an appropriate repetition rate in real-time, is described here. The algorithm that this mechanism uses to make its decision is written in text files and expressed in states of the accelerator and its devices, one file per accelerator region. Before being used, a file is "compiled" to a binary format which can be easily processed as a forward-chaining decision tree. It is processed by distributed microcomputers local to the accelerator regions. A parent algorithm evaluates all results, and reports directly to the beam control microprocessor. Operators can test new algorithms, or changes they make to them, with an online graphical NPS simulator.

7209 (SLAC-PUB–6293) **A test accelerator for the next linear collider.** Ruth, R.D.; Adolphsen, C.; Bane, K.; Boyce, R.F.; Burke, D.L.; Callin, R.; Caryotakis, G.; Cassel, R.; Clark, S.L.; Deruyter, H.; Fant, K.; Fuller, R.; Heifets, S.; Hoag, H.; Humphrey, R.; Kheifets, S.; Koontz, R.; Lavine, T.; Loew, G.A.; Menegat, A.; MillStanford Linear Accelerator Center, Menlo Park, CA (United States). Jul 1993. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9207224–1: European Community for Future Accelerators (ECFA) workshop on $e^{+)e(sup-}$ linear colliders (LC92), Garmisch-Partenkirchen (Germany), 25 Jul - 2 aug 1992). Order Number DE94003441. Source: OSTI; NTIS; INIS; GPO Dep.

At SLAC, the authors are pursuing the design of a Next Linear Collider (NLC) which would begin with a center-of-mass energy of 0.5 TeV, and be upgradable to at least 1.0 TeV. To achieve this high energy, they have been working on the development of a high-gradient 11.4-GHz (X-band) linear accelerator for the main linac of the collider. In this paper, they present the design of a "Next Linear Collider Test Accelerator" (NLCTA). The goal of the NLCTA is to incorporate the new technologies of X-band accelerator structures, RF pulse compression systems and klystrons into a short linac which will then be a test bed for beam dynamics issues related to high-gradient acceleration.

7210 (SLAC-PUB–6312) **Linac Coherent Light Source (LCLS) at 2–4 nm using the SLAC linac.** Seeman, J.T. (Stanford Linear Accelerator Center, Menlo Park, CA (United States)); Bane, K.; Boyce, R.; Loew, G.; Morton, P.; Nuhn, H.D.; Paterson, J.; Pianetta, P.; Raubenheimer, T.; Tatchyn, R.; Vylet, V.; Winick, H.; Pellegrini, C.; Rosenzweig, J.; TravStanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (LBL–33456; CONF-930722–56: Annual meeting of the Society of Photo-Optical Instrumentation Engineers (SPIE), San Diego, CA (United States), 11-16 Jul 1993). Order Number DE94005235. Source: OSTI; NTIS; INIS; GPO Dep.

The authors describe the possible use of the SLAC linac to drive a unique, powerful, short wavelength Linac Coherent Light Source (LCLS). Using the FEL principle, lasing is achieved in a single pass of a high peak current electron beam through a long undulator by self-amplified-spontaneous-emission (SASE). The main components are a high-brightness electron RF gun with a photocathode, two electron bunch length compressors, the existing SLAC linac, beam diagnostics, and a long undulator combined with a FODO quadrupole focusing system. The RF gun, to be installed about 1 km from the end of the SLAC linac, would produce a single bunch of 6 x 10^9 electrons with an invariant emittance of about 3 mm-mrad and a bunch length of about 500 μm. That bunch is then accelerated to 100 MeV and compressed to a length of about 200 μm. The main SLAC linac accelerates the bunch to 2 GeV were a second bunch compressor reduces the length to 30–40 μm and produces a peak current of 2–3 kA. The bunch is then accelerated to 7–8 GeV and transported to a 50–70 m long undulator. Using electrons below 8 GeV, the undulator could operate at wavelengths down to 2 nm, producing about 10 GW peak power in sub-ps light pulses. At a linac repetition rate of 120 Hz, the average power is about 1 W. Linac operation at lower beam energies provides longer wavelength radiation. After the undulator, the beam is deposited in a dump. The LCLS light pulses are then distributed to multiple user stations using grazing incident mirrors. Length compression, emittance control, phase stability, FEL design criteria, and parameter tolerances are discussed. A demonstration experiment is also described which uses the SLAC linac and (possibly) the PALADIN undulator to study SASE to power saturation at wavelengths of 40–360 nm.

7211 (SLAC-PUB–6313) **SLC and SLD: Experimental experience with a linear collider.** Breidenbach, M. SLD and SLC Collaborations. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930449–8: International workshop on physics and instrumentation at future linear colliders, Kona, HI (United States), 26-30 Apr 1993). Order Number DE94003435. Source: OSTI; NTIS; INIS; GPO Dep.

The SLAC Linear Collider (SLC) is the prototype e^+e^- linear collider. This talk will consist of an introduction to SLC, a description of the strategy for luminosity, a description of the systems for the transport and measurement of the polarized electrons, and a description of the present performance of the SLC and planned upgrades. The detector, SLD, and the status of the polarization asymmetry measurement A_{LR} will be described.

7212 (SLAC-PUB–6334) **Linear collider development at SLAC.** Irwin, J. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930449–10: International workshop on physics and instrumentation at future linear colliders, Kona, HI (United States), 26-30 Apr 1993). Order Number DE94003445. Source: OSTI; NTIS; INIS; GPO Dep.

Linear collider R&D at SLAC comprises work on the present Stanford Linear Collider (SLC) and work toward the next linear collider (NLC). Recent SLC developments are summarized. NLC studies are divided into hardware-based and theoretical. We report on the status of the NLC Test Accelerator (NLCTA) and the final focus test beam (FFTB), describe plans for ASSET, an installation to measure accelerator structure wakefields, and mention IR design developments. Finally we review recent NLC theoretical studies, ending with the author's view of next linear collider parameter sets.

7213 (SLAC-PUB–6355) **e^+e^- collisions at the SLC–the left-right asymmetry.** Prescott, C.Y. SLD Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Sep 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9307158–1: International conference on neutral currents twenty years later, Paris (France), 6-9 Jul 1993). Order Number DE94003430. Source: OSTI; NTIS; INIS; GPO Dep.

Recent progress with the SLC as a prototype linear collider for high energy e^+e^- collisions is reviewed. Recent advances in the production of high intensity beams of polarized e^{-s} are also discussed. The SLD Collaboration has embarked on a precision measurement of the left-right polarization asymmetry A_{LR} at the Z pole with polarized electrons. Results and future plans are presented.

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Refer also to citation(s) 7263, 7276

7214 (BNL–48941) **Stochastic cooling requirements for a muon collider.** Ruggiero, A.G. Brookhaven National Lab., Upton, NY (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9310193–8: CERN workshop on beam cooling and related topics, Geneva (Switzerland), 4-8 Oct 1993). Order Number DE94004973. Source: OSTI; NTIS; INIS; GPO Dep.

The most severe limitation to the muon production for a large-energy muon collider is the short time allowed for cooling the beam to dimensions small enough to provide reasonably high luminosity. The limitation is caused by the short lifetime of the particles. It appears to be desirable to accelerate the beam quickly in very short bunches. This paper describes the requirements of single-pass, fast stochastic cooling for very short bunches. Bandwidth, amplifier gain and Schottky power do not seem to be of major concern. Problems do arise with the ultimate low emittance that can be achieved, the value of which is seriously affected by the front-end noise.

7215 (BNL–49312) **Effects of the third order transfer maps and solenoid on a high brightness beam.** Parsa, Z. Brookhaven National Lab., Upton, NY (United States). May 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CAP–102-93C; CONF-930511–502: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94004234. Source: OSTI; NTIS; INIS; GPO Dep.

We present a sketch of the formulation for obtaining Lie algebraic transfer maps for the solenoid through third order and its effect on the beam of charged particles. We discuss simulation results showing effects of solenoids on the laser driven high brightness photoelectrons for the proposed alternate injection system for Brookhaven Accelerator Test Facility.

7216 (BNL–49554-Rev.) **Derivation of a Fokker-Planck equation for bunched beams: Revision.** Ruggiero, A.G. Brookhaven National Lab., Upton, NY (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9310193–10-Rev.: CERN workshop on beam cooling and related topics, Geneva (Switzerland), 4-8 Oct 1993). Order Number DE94004950. Source: OSTI; NTIS; INIS; GPO Dep.

This report investigates the derivation of the Fokker-Planck equation which is used to evaluate the evolution with time of an ensemble of particles under the effect of external rf forces, cooling and forces of stochastic nature. The conventional approach based on the classical work by Chandrasekhar is first outline: here the phase angle and the momentum error of the particles are used. The method is then extended to the case the distribution function is expressed in terms of the amplitude of motion. To avoid a singularity behavior, the new Fokker-Planck equation is obtained with an averaging process over the phase distribution instead of the time-averaging. The beam lifetime in the presence of the separatrix of the rf buckets is determined. Finally, the numerical estimates apply to the Relativistic Heavy Ion Collider (RHIC).

7217 (BNL–49743) **Demonstration of no feasibility of a crystalline beam in a Betatron Magnet II.** Ruggiero, A.G. Brookhaven National Lab., Upton, NY (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9310193–9: CERN workshop on beam cooling and related topics, Geneva (Switzerland), 4-8 Oct 1993). Order Number DE94004971. Source: OSTI; NTIS; INIS; GPO Dep.

This paper investigates the feasibility of a Crystalline Beam in a weak-focusing Betatron Magnet. The curvature effect due to the bending magnet is also investigated. The case of circular one- dimensional string of electrically-charged particles is examined. It is found that the motion is unstable due to the dependence of the precession movement with the radial displacement. That is a form of negative-mass instability which can be avoided with an alternating-focussing structure. The calculation of the particle-particle interaction as well as of the forces due to the external magnetic field is done directly in the laboratory frame.

7218 (FNAL/C–93/308) **Theory, technology, and technique of stochastic cooling.** Marriner, J. Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9310193–6: CERN workshop on beam cooling and related topics, Geneva (Switzerland), 4-8 Oct 1993). Order Number DE94003645. Source: OSTI; NTIS; INIS; GPO Dep.

The theory and technological implementation of stochastic cooling is described. Theoretical and technological limitations are discussed. Data from existing stochastic cooling systems are shown to illustrate some useful techniques.

7219 (IFVE-OLU–91-104) **On possibility of application of RFQ focusing in proton linacs at energies 100 MeV and above.** Barsukov, A.B.; Budanov, Yu.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1991. 6p. (In Russian). Order Number DE94610738. Source: OSTI; NTIS (US Sales Only); INIS.

Qualitative argumentations and quantitative estimations for application of HF-quadrupole focusing in proton linacs at energies, exceeding 100 MeV, are presented. It is shown that accelerating struture with HF-quadrupoles is more homogeneous. There is no need couplers between sections which simplifies tuning of resonators. HF-quadrupoles don't cause sufficient design complications. This enables to recommend the given focusing for meson factories, μ-catalysis, electronuclear breeding facilities and other possible applications. 10 refs.; 1 fig.; 2 tabs.

7220 (IFVE-OP–91-155) **Operation of the bent single crystal in intense beams.** Galyaev, N.A.; Gres', V.N.; Dudenko, V.V.; Zapol'skij, V.N.; Kotov, V.I.; Terekhov, V.I.; Tsarik, S.V.; Chesnokov, Yu.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1991. 6p. (In Russian). Order Number DE94610739. Source: OSTI; NTIS (US Sales Only); INIS.

The purpose of this paper is to study the possibility of intense proton beam formation, using monocrystal, sufficient for generation of secondary particle beams. Silicon crystal, bent by the angle of 13 mrad deflected a part of 70 GeV proton beam of 1.3×10^{13} intensity in the cycle at 5 μs extraction duration and 9 s cycle repetition time. It is shown that the beam of $\approx 10^{11}$/cycle can be shapes if crystal is located in the beam of similar high density, but with less angular divergence. The intense beam extraction by a crystal in colliders can stimulate the creation of experimental base for fixed target investigations. 7 refs.; 5 figs.

7221 (IFVE-UNK–92-22) **Numerical method to study the stability of periodic solutions of particle motion in nonlinear magnetic fields.** Fedotov, Yu.S. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1992. 11p. (In Russian). Order Number DE94610740. Source: OSTI; NTIS (US Sales Only); INIS.

The equations of betatron oscillations in nonlinear magnetic fields belong to the Lyapunov systems having a number of periodic solutions. Using the matrix methods developed for studying periodic linear systems one can construct the algorithm for searching these solutions and studying their stability in order to determined the region of stable motion. The present note describes the method of numeric search for the periodic solutions of two-dimensional betatron motion, using the nonlinear element in thin-lens approximation. To illustrate the technique, the results on calculating the pattern on the phase plane close to the line and node of the sum third-order resonance are presented. 5 refs.; 5 figs.

7222 (IYaF–92-54) **Application of proper magnetic field for high-current REB modulation.** Astrelin, V.T.; Lebedev, S.V. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1992. 10p. (In Russian). Order Number DE94610741. Source: OSTI; NTIS (US Sales Only); INIS.

A method is proposed for high-current relativistic electron beam modulation. The method are not connected with the beam space charge. In the proposed approach is used the proper magnetic field of the beam and is supposed that the beam is neutralized in space charge in the region of beam transport. 10 refs.; 4 figs.

7223 (LBL–34836) **Coulomb field effect on plasma focusing and wake field acceleration.** Amatuni, A.Ts. (Yerevan Physics Inst. (Armenia)); Elbakian, S.S.; Sekhpossian, E.V. Lawrence

Berkeley Lab., CA (United States). Nov 1993. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94004937. Source: OSTI; NTIS; INIS; GPO Dep.

It is shown that the fields generated by relativistic electron (positron) bunches moving in overdense cold plasma have two components – wake and Coulomb. The existence of the Coulomb component is caused by the absence of the Debay screening of the charge moving in plasma with the velocity greater than the thermal velocity of the plasma electrons. It is shown that at some conditions the contribution of the Coulomb component to focusing and self-focusing of the electron (positron) bunches, and wake field generation could be essential. This conclusion is valid for different descriptions of cold plasma-relativistic electron bunch system.

7224 (SLAC-PUB–6052) **Introduction to impedance for short relativistic bunches.** Morton, P.L. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Feb 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9210313–4: Joint US/CERN school on particle accelerators frontiers of particle beams: factories with e^+e^- rings, Benalmadena (Spain), 28 Oct - 5 nov 1992). Order Number DE94003459. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this paper is to introduce the concept of impedance to calculate the wake field forces left behind by a short bunch which travels at relativistic speed through a structure with discontinuities. We will try to be as intuitive as possible and leave the more rigorous derivations to the second paper on this subject by J. Wang.

7225 (SLAC-PUB–6202) **Induced beam oscillations from quadrupole vibrations in the SLC linac.** Seeman, J.T.; Holtzapple, R.L.; Ross, M.C. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930511–505: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94005238. Source: OSTI; NTIS; INIS; GPO Dep.

Linac beams in the Stanford Linear Collider (SLC) were driven into oscillation by transverse vibration of lattice quadrupoles at about 7 Hz. These quadrupoles are centered on 12-meter support girders located early in the linac. The vibrations were caused by ground motion at the 0.06 μm level which was amplified in the accelerator supports up to 5 μm. Seismic and support vibration measurements were Fourier analyzed and a strong correlation with beam observations was observed. Subsequent modifications of the supports have eliminated these oscillations.

7226 (SLAC-PUB–6204) **Measured optimum BNS damping configuration of the SLC linac.** Seeman, J.T.; Decker, F.J.; Holtzapple, R.L.; Spence, W.L. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930511–506: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94005236. Source: OSTI; NTIS; INIS; GPO Dep.

Transverse wakefield (or BNS[1]) damping has been successfully used in the linac of the Stanford Linear Collider (SLC) to reduce emittance enlargement from beam trajectory jitter coupled with transverse wakefields. The authors are presently in the process of raising the bunch intensities from 3×10^{10} particles per bunch to over 4×10^{10}. With these higher currents the RF phasing configuration which produces BNS damping must be improved. Too little damping allows excessive emittance growth from jitter but too much damping increases emittance growth from chromatic effects and produces an unacceptable loss of overall energy. Several experiments were performed to find the optimum settings for the present situation. An empirical optimum was found with a combination of (1) somewhat stronger BNS RF phase settings in the upstream section of the linac and (2) a stronger quadrupole lattice in the downstream section.

7227 (SLAC-PUB–6326) **Simulations of low energy e^+e^- particle backgrounds.** Ronan, M.T. (Lawrence Berkeley Lab., CA (United States)). Stanford Linear Accelerator Center, Menlo Park, CA (United States); Lawrence Berkeley Lab., CA (United States). Aug 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515 ; AC03-76SF00098. (LBL–34488; CONF-930449–9: International workshop on physics and instrumentation at future linear colliders, Kona, HI (United States), 26-30 Apr 1993). Order Number DE94003443. Source: OSTI; NTIS; INIS; GPO Dep.

A progress report on simulations of low-energy e^+e^- backgrounds from the beam-beam interaction at future linear colliders is given. Characteristics of the primary particles and detailed calculations of the backgrounds fron backscattering into the detector volume are presented.

7228 (SLAC-PUB–6332) **Obtaining slow beam spills at the SSC collider.** Ritson, D. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9306258–11: Workshop on B physics at hadron colliders, Snowmass, CO (United States), 21 Jun - 2 jul 1993). Order Number DE94003444. Source: OSTI; NTIS; INIS; GPO Dep.

There is substantial interest in providing slow-spill external proton beams in parallel with "interaction running" at the 20 TeV SSC collider. The proposal is to cause a flux of particles to impinge on a target consisting of a bent crystal extraction channel. Additionally, a slow spill onto a conventional internal target could be used as a source of secondary beams for physics or test purposes and might also be used for B-physics as proposed for HERA. The "natural" beam loss rates from elastic and diffractive beam gas scattering and IP collisions are not sufficient to provide suitably intense external proton beams. To prevent loss of luminosity, the rf excitation is non-linear and preferentially blows up the halo of the beam. The "target" is to be located at a region of high dispersion forcing particles at the edge of the momentum space onto the target. T. Lohse in this workshop has described a proposed internal target to be used at HERA that will not employ rf excitation but will use the finite loss rates observed at the HERA machine. The Hera losses are caused by a variety of sources in addition to beam gas scattering or IP interactions. Initially, the beam lifetime at HERA was too short to obtain satisfactory integrated luminosities. Subsequently, through careful attention to detail, the beam lifetime was increased to > 20 hours. Even with these changes, present loss rates provide the required intensity onto an internal target. The Tevatron and SPS proton anti-proton colliders have had similar experiences with their investigations of loss rates and also find that beam lifetimes may be substantially shorter than expected solely from beam gas and IP interactions. This paper proposes deliberately introducing controlled errors.

7229 (SSCL–654) **Beam line error analysis, position correction, and graphic processing.** Wang, Fuhua; Mao, Naifeng. Superconducting Super Collider Lab., Dallas, TX (United States). Nov 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE94004330. Source: OSTI; NTIS; INIS; GPO Dep.

A beam transport line error analysis and beam position correction code called "EAC" has been developed in association with a graphics and data post-processing package for TRANSPORT. Based on the linear optics design using TRANSPORT or other general optics codes, EAC independently analyzes effects of magnet misalignments, and systematic and statistical errors of magnetic fields, as well as the effects of the initial beam positions on the central trajectory and on the transverse beam emittance dilution. EAC also provides an efficient way to develop beam line trajectory correcting schemes. The post-processing package generates various types of graphics including beam line geometrical layout, plots of the Twiss parameters, and beam envelopes. It also generates an EAC input file, thus connecting EAC with general optics codes. EAC and the post-processing package are small codes that are easy to access and use. They have become useful tools for the design of transport lines at the Superconducting Super Collider Laboratory.

4303 Auxiliaries and Components

Refer also to citation(s) 6976, 7208, 7229, 7289, 7299, 7310, 7312, 7316, 7318, 7319, 7325, 7344, 7345, 7347, 7348, 7567

7230 (ANL/APS/TM–13) **International Workshop on Magnetic Measurements of Insertion Devices.** Argonne National Lab., IL (United States). Oct 1993. 344p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9309285–: International workshop on magnetic measurements of insertion devices, Argonne, IL (United States), 28-29 Sep 1993). Order Number DE94004331. Source: OSTI; NTIS; INIS; GPO Dep.

The International Workshop on Magnetic Measurements of Insertion Devices was held at the Advanced Photon Source, Argonne National Laboratory, on September 28–29, 1993. The workshop brought together scientists and engineers from Europe, Japan, and the United States to discuss the following topics: Special techniques for magnetic measurements of insertion devices, magnetic tolerances of the insertion devices for third generation synchrotron radiation sources, methods for and accuracy of the multipole moments measurements, magnetic sensors, among other topics. The workshop included thirteen presentations that are collected in this volume.

7231 (ANL/ASD/CP–80715) **Diagnostics for the APS undulator test line.** Lumpkin, A.H.; Ciarlette, D.; Kahana, E.; Patterson, D.; Sellyey, W.; Wang, X. Argonne National Lab., IL (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310204–9: Beam instrumentation workshop, Santa Fe, NM (United States), 20-23 Oct 1993). Order Number DE94002911. Source: OSTI; NTIS; INIS; GPO Dep.

One of the research and development thrusts at the Advanced Photon Source (APS) is to use an rf gun as a low-emittance electron source for injection into the 100- to 650-MeV linac subsystem and subsequent transport to an undulator test area. This configuration would combine the acceleration capability of the 200-MeV S-band electron linac and the in-line 450-MeV positron linac that normally provide positrons to the positron accumulator ring (PAR). A transport line that bypasses the PAR will bring the electrons to the undulator test area. Characterization techniques will be discussed for the electron beam with a normalized, rms emittance of $<10\ \pi$ mm mrad ($l\sigma$) at micropulse charges of up to 350 pC and micropulse durations of ~5 ps (FWHM). Preservation of such beam properties will be critical. The diagnostics planned, with resolutions in parentheses, include the beam position monitors based on stripline pickups (100 μm), current monitors based on a transformer (60 μA), beam profile monitors (25 μm FWHM), and bunch length monitor based on a streak camera (2 ps). Tests proposed include measurement of particle beam transport effects (at one-tenth the storage ring beam rigidity) caused by small undulator field errors.

7232 (ANL/ASD/CP–80718) **Configuration and test of the APS storage ring beam position monitor electronics.** Kahana, E.; Chung, Y.; Votaw, A.J.; Lenkszus, F. Argonne National Lab., IL (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310204–10: Beam instrumentation workshop, Santa Fe, NM (United States), 20-23 Oct 1993). Order Number DE94002917. Source: OSTI; NTIS; INIS; GPO Dep.

This paper will present the final tests of the APS storage ring BPM electronic system. The final configuration includes the filter-comparator installed in the accelerator tunnel and the signal conditioning and digitizing unit (SCDU) in a VXI configuration. The SCDU includes an AM/PM monopulse receiver at 352 MHz. Extensive testing was performed on the system. The key parameters measured were the null cancellation better than 45 db, dynamic range of better than 40 db, single bunch capability with 0.01 mA sensitivity, and a resolution better than 10 micron for 512 averaged turns. This last critical performance was tested using a moving wire to simulate the beam. This report will concentrate on the wire test results. Also, the actual production hardware will be presented.

7233 (ANL-HEP-TR–93-101) **Proposal for the completion of outstanding work on the installation scheduling and alignment of the SDC central calorimeter.** Guarino, V.; Hill, N.; Nasiatka, J.; Petereit, E.; Price, L. Argonne National Lab., IL (United States). 18 Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94004579. Source: OSTI; NTIS; INIS; GPO Dep.

The High Energy Physic Division at Argonne National Laboratory was given the task of developing the procedures, fixtures, and schedules for the final assembly of the barrel and endcap calorimeters for the SDC. The work completed led to some major decision about how and where this assembly work would be done. The primary assembly decision was the feasibility of assembling the major detector components (barrel and endcap sub-assemblies) above ground and lowering them into position in the experimental hall, as opposed to assembling the calorimeter directly in the experimental hall. Due to cost of above ground assembly and schedule changes, the in-hall option was adopted. Although no actual hardware was constructed, many conceptual ideas were formalized and brought to workable solutions as a result of the effort put forth at ANL.

7234 (ANL/PHY/CP–81316) **Superconducting rf development at ATLAS.** Shepard, K.W. (Argonne National Lab., IL (United States)); Kedzie, M.; Clifft, B.E.; Roy, A.; Potukuchi, P.; Givens, J.; Potter, J.; Crandall, K.; Added, N. Argonne National Lab., IL (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States);Government of India, New Delhi (India). DOE Contract W-31-109-ENG-38 ; FG03-91ER81098. (CONF-931039–3: 6. workshop on RF superconductivity, Newport News, VA (United States), 4-8 Oct 1993). Order Number DE94004570. Source: OSTI; NTIS; GPO Dep.

The ATLAS superconducting heavy-ion linac began operation in 1978 and has operated nearly continuously since that time, while undergoing a series of upgrades and expansions, the most recent being the "uranium upgrade" completed earlier this year and described below. In its present configuration the ATLAS linac consists of an array of 64 resonant cavities operating from 48 to 145 MHz, which match a range of particle velocities $.007 < \beta = v/c < .2$. The linac provides approximately 50 MV of effective accelerating potential for ions of $q/m > 1/10$ over the entire periodic table. Delivered beams include 5 – 7 pnA of $^{238}U^{39+}$ at 1535 MeV. At present more than 10^6 cavity-hours of operation at surface electric fields of 15 MV/m have been accumulated. Superconducting structure development at ATLAS is aimed at improving the cost/performance of existing low velocity structures both for possible future ATLAS upgrades, and also for heavy-ion linacs at other institutions. An application of particular current interest is to develop structures suitable for accelerating radioactive ion beams. Such structures must accelerate very low charge to mass ratio beams and must also have very large transverse acceptance.

7235 (ANL/XFD/CP–79550) **Survey of hardware supported by the Control System at the Advanced Photon Source.** Coulter, K.J.; Nawrocki, G.J. Argonne National Lab., IL (United States). [1993]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931023–11: International conference on accelerator and large experimental control systems, Berlin (Germany), 18-22 Oct 1993). Order Number DE94004619. Source: OSTI; NTIS; INIS; GPO Dep.

The Experimental Physics and Industrial control System (EPICS) has been under development at Los Alamos and Argonne National Laboratories for over six years. A wide variety of instrumentation is now supported. This presentation will give an overview of the types of hardware and subsystems which are currently supported and will discuss future plans for addressing additional hardware requirements at the APS. Supported systems to be discussed include: motion control, vacuum pump control and system monitoring, standard laboratory instrumentation (ADCs, DVMs, pulse generators, etc.), image processing, discrete binary and analog I/O, and standard temperature, pressure and flow monitoring.

7236 (ANL/XFD/CP–80249) **A ray-tracing study of inclined double-crystal monochromators.** Blasdell, R.C.; Macrander, A.T.; Lee, W.K. Argonne National Lab., IL (United States). Dec 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-930824–30: Synchrotron radiation instrumentation, Gaithersburg, MD (United States), 23-26 Aug 1993). Order Number DE94004617. Source: OSTI; NTIS; INIS; GPO Dep.

Third generation synchrotron X-ray sources such as the Advanced Photon Source (APS) under construction at Argonne National Laboratory will place severe heat load demands on the first beamline optical element. A cooled, inclined double-crystal

monochromator is one of the methods being developed at the APS to handle these high heat loads while retaining the brilliance of the source. Using a modified version of the 1989 VAX/VMS SHADOW code, the authors examine the properties of the exit beam for two inclined double-crystal monochromator geometries.

7237 (ANL/XFD/CP–81491) **Multiple exposure CCD detector for high-speed laser pump, x-ray probe Laue scattering.** Rodricks, B. Argonne National Lab., IL (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931237–2: International conference on lasers and applications, Lake Tahoe, NV (United States), 6-10 Dec 1993). Order Number DE94004618. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the four CCD fiber-optic coupled detector and detector control electronics and image displays.

7238 (BNL–49420) **Amended proposal for R&D on a cluster klystron.** Fernow, R.C.; Fischer, J.; Gallardo, J.C.; Kirk, H.G.; Ko, S.K.; Palmer, R.B.; Ulc, S.; Wang, H. Brookhaven National Lab., Upton, NY (United States). Jan 1993. 57p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CAP–103-CK-93R). Order Number DE94004348. Source: OSTI; NTIS; INIS; GPO Dep.

This Proposal is an updated version of FWP submitted in March 1992. Significant work has been done since the original proposal, and much of this is reported on in this update. In addition there have been several changes made, some in response to suggestions made by the three reviews sent to us in December, 1992. The new information and changes include: Technical information on the proposed design of the magnetron gun, the magnet, acceleration gap, and electrical system (including a comment on efficiency loss due to high-voltage leakage current). Modification of the phase I and II tests to allow operation of the gun and klystron off the axis of the magnet, thus simulating the magnet situation when multiple beams are used. Modification of phases III and IV to test a cluster of three beams: first a three beam gun, and then three beams with a klystron on one of them. We have added a phase V which would be the testing of a full three-beam demonstration klystron. The mod-anode pulser would now be located on the high voltage deck instead of externally. Power for the pulser and other high voltage components would now be provided by an isolation transformer instead of from a lead battery. We believe these changes have improved the proposed program and thank the reviewers for their constructive suggestions. The design is still evolving. Relatively little work has been done on the detailed klystron design, and none on the beam dump.

7239 (BNL–49648) **Full cycle beam diagnostics with an ionization profile monitor.** Stillman, A.; Thern, R.E. Brookhaven National Lab., Upton, NY (United States). 14 May 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-930511–500: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94003990. Source: OSTI; NTIS; INIS; GPO Dep.

The Alternating Gradient Synchrotron Booster at Brookhaven National Laboratory uses an ionization profile monitor to generate profiles of proton and heavy-ion beams. The profile monitor can acquire hundreds of profiles during an acceleration cycle, and then display and store them for analysis. Profiles appear in real time on an oscilloscope-type display, but other visualizations are available as well, namely mountain range and emittance displays. File storage of profile data is simple, as is the storage of moments and emittances.

7240 (BNL–70389) **Travel to the collaboration meeting of the RD5 experiment at CERN.** Polychronakos, V.A. Brookhaven National Lab., Upton, NY (United States). 28 Dec 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE94004968. Source: OSTI; NTIS (US Sales Only); GPO Dep.

A large group of physicists and engineers from Brookhaven National Laboratory were participating in the GEM (Gammas, Electrons, Muons) Experiment at the Superconducting Supercollider Laboratory (SSC). One of the two main activities of the group was the development of the Endcap Muon System. A set of prototype detectors has been constructed by the BNL team in collaboration with groups from Boston University, the State University of New York at Stony Brook and the St. Petersburg Nuclear Physics Institute, Russia. A collaboration has been established with the Compact Muon Solenoid group (CMS) at CERN which is also interested in this detector technology. Preliminary results on the spatial as well as timing resolution of prototype detectors tested at CERN last September were presented during the RD5 collaboration meeting on November 15, 1993. In addition I participated in numerous discussions on the possibility of collaboration with the CMS experiment after the demise of the SSC.

7241 (CONF-9210121–, pp. 131-135) **Resonant laser ion sources for high elemental selectivity.** Fairbank, W.M. (Colorado State Univ., Fort Collins, CO (United States)); Barrera, A.; Carter, H.K.; Newton, K.R.; Trivedi, A.C. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. DOE Contract AC05-76OR00033. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

Laser ion sources based on resonance ionization of neutral atoms are reviewed. Progress on the development of a laser ion source based on helium jet transport, laser ablation and resonance ionization is reported.

7242 (CONF-9210121–, pp. 171-212) **Production of high intensity radioactive ion-beams by means of thick target technique.** Ravn, H.L. (CERN ISOLDE, Geneva (Switzerland)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

Target and ion-source techniques which allow rapid separation of thermalized radioactive nuclei from 1-500 g/cm^2 thick irradiated target material and continuously convert them into a mono-isotopic ion-beam present themselves as a new method of radiochemical separation. These techniques combine nuclear reactions with high temperature chemistry, metallurgy, solid state diffusion and ionization phenomena. Developed at the many mass separators on-line at various accelerators or reactors they are today widely used to produce radioactive ion-beams for physics experiments. For some years they have reached a stage of development that allows the production of low-energy high-intensity beams of radioactive isotopes of most elements in the periodical system. In this paper the parameters that determine the intensities of these most often singly charged ion-beams are discussed in view of injection into a post accelerator. First a short introduction is given to the technique of on-line mass separation. This is followed by a detailed discussion of the three factors which determine the production rates in the target: i.e. reaction cross sections, beam properties and target thicknesses and by a discussion of the more decisive factors which control the efficiency with which the radioactive nuclei produced in the target can be transformed into a final ion-beam of typically 10-60 keV energy. Throughout the discussion the influence and direction of new developments are assessed. Finally, selected examples of realistic beam intensities are given, which may be used for comparison of the different production methods.

7243 (CONF-9210121–, pp. 213-222) **Isobar separators for radioactive beam facilities.** Wollnik, H. (Univ. of Giessen (Germany)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

Efficient high performance on-line isotope separator designs are discussed as needed in radioactive ion beam (RIB) facilities. It is described that good results can be expected only from multistage systems which should advantageously act on the ions at different acceleration levels.

7244 (CONF-9210121–, pp. 223-242) **Radiation problems at an ISL facility.** Thorson, I.M. (TRIUMF, Vancouver, British Columbia (Canada)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

The problems associated with the high radiation field and large quantities of residual radioactivity induced in beam-line components and shields and released from production targets in a high beam power (~50 kW) ISL facility are estimated. A conceptual design that accommodates these constraints is described.

7245 (CONF-9210121–, pp. 245-285) **Report from discussion group on targets, ion sources, and mass separators for ISL.** D'Auria, J.M. (Simon Fraser Univ., Burnaby, British Columbia (Canada)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

The present conceptual plan for an ISL facility is the so-called benchmark facility (BMF) described in the ISL white paper. This conceptual plan is a first version of a high-intensity, accelerated-radioactive-beam facility that meets the desired specifications of an ISL. This approach is based upon a thick-target ISOL system combined with a post-accelerator. The purpose of this section of the workshop was to provide a through review of the technical aspects of the front end of this proposed facility by experts and interested observers. The specified goals of this session were: to receive advice from experts and interested observers on technical aspects of the front end of the ISL (BMF); to discuss identified and unidentified problem areas and questions, indicating their importance and priority, and proposing paths to their solution; to indicate areas requiring further research and development studies; and to develop lines of communication for providing assistance for the ORNL RIB project. The discussion included, but was not limited to problems related to target systems (including realistic production yields with protons and heavy ions); ion sources; extraction systems; ion-beam elements (including the mass-separator systems); isobaric separators; radiation effects on materials; robotic and remote-handling systems; shielding requirements; vacuum and pumping requirements; space, manpower, and cost requirements; and related items. High-priority research and development projects were identified for further study.

7246 (CONF-9210121–, pp. 289-292) **A test facility for radioactive ions generated by intense beams of high energy protons.** Bennett, J.R.J. (SERC, Rutherford Appleton Lab., Chilton, Didcot, Oxon (United Kingdom)); Broome, T.A.; Densham, C.J.; Gelletly, W.; Price, H.G.; Warner, D.D. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

A proposal for a radioactive beam test-bed facility at the Rutherford Appleton Laboratory is described. The facility is aimed at testing and developing target/ion source technology with proton beam intensities of up to 100μA.

7247 (CONF-9210121–, pp. 293-299) **Design principles for target stations and methods of remote handling at PSI.** Steiner, E. (Los Alamos National Lab., NM (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

Two design concepts for target stations used at the Paul Scherrer Institute PSI are shown. The method of the remote handling of activated elements is described and some conclusions with respect to a radioactive beam facility are given.

7248 (CONF-9210121–, pp. 301-304) **Considerations of the low-velocity stage of a radioactive beams accelerator.** Talbert, W.L. (Los Alamos National Lab., NM (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

Studies of the low-velocity stages of a radioactive beams accelerator are summarized, highlighting the limitations of existing RFQ technology when applied to the specification of the IsoSpin Laboratory.

7249 (CONF-9210121–, pp. 305-307) **Ion sources for the ISL-project.** Van Duppen, P. (Instituut voor Kern - en Stralingsfysika, K.U. Leuven, Leuven (Belgium)); Huyse, M. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

This paper briefly reviews the types of ion sources available for applications to generating radioactive ion beams. The interest is in sources which will generate currents appreciable enough for beam applications. Gaseous discharge ion sources, surface-ionization sources, and thermoionizing cavities are fairly well understood. A presentation in this conference reviewed laser ionization ion sources. Here the authors address the electron cyclotron resonance ion sources. They deal with a few features of these sources which are relevant to the ISL project.

7250 (CONF-9210121–, pp. 309-311) **A radioactive ion production R&D program using a helium-jet coupled target ion source.** Wouters, J.M. (Los Alamos National Lab., NM (United States)); Vieira, D.J.; Talbert, W.L. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

A brief outline of plans to test a He-jet fed mass separator at the Los Alamos Meson Physics Facility (LAMPF) is described.

7251 (CONF-9210121–, pp. 317-332) **The role of cyclotrons as primary and secondary beam accelerators.** Jongen, Y. (Ion Beam Applications s.a., Chemin du Cyclotron, Louvain-la-Neuve (Belgium)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

Different kinds of accelerators can meet the specifications of the primary accelerator of the ISL. Among those, positive and negative ion isochronous cyclotrons are more specifically discussed. A fixed field, alternating gradient ring accelerator could represent a new, but still unproven, alternative. For the secondary accelerator, a high field, superconducting cyclotron could cover the required energy range, provided that a charge to mass ratio of 1/10 is available for the highest energies. The main quality of such a cyclotron would be its flexibility, and the main disadvantage would be a transmission probably smaller than required.

7252 (CONF-9210121–, pp. 333-340) / **Some aspects of linacs as applied to the ISL benchmark facility.** Shepard, K.W. (Argonne National Lab., IL (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

This paper considers several aspects of using linacs in a radioactive beam facility in terms of the Isospin Laboratory (ISL) Benchmark Facility (BMF) plan, described in the 1991 white paper for a possible radioactive-beam laboratory. The intention is not to review comprehensively the application of linacs to an ISL facility, but to compare in outline form several linac options for such a facility. Particular emphasis is given to the use of superconducting rf technology for the secondary beam accelerator. In what follows, first a possible normally-conducting light-ion linac for a primary beam accelerator is briefly outlined. Then the performance and cost of two options for a secondary beam accelerator are compared: a recent design for a normal-conducting cw linac, and an ATLAS-type superconducting linac. Finally, some of the problems which may be encountered at the entrance of a secondary beam linac are discussed. The author has included cost estimates with some reluctance and only because it is impossible to compare technical options without some discussion of costs. Although an effort has been made to indicate the sources and assumptions underlying cost estimates, please note that any costs mentioned must be considered as 'ball-park' numbers useful for only the most rudimentary planning. Even for elements of the BMF which can be modeled on existing linacs, cost comparisons between different institutions can be difficult to make. Cost estimates for elements based on untested designs or future technical development are necessarily highly speculative.

7253 (CONF-9210121–, pp. 343-350) **Report from discussion group on accelerators-primary and secondary.** Nitschke, J.M. (Lawrence Berkeley Lab., CA (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

The ISL White Paper (WP) offers many options in the choice of primary and secondary accelerators, and existing facilities (such as ISIS, PSI, LAMPF, TRIUMF. ATLAS, ISOLDE, and Louvain) can serve as models in selecting a configuration. With the Benchmark Facility of the WP as a starting point, the ISL concept has now been expanded in several ways. Three target stations are desired to ensure uninterrupted RNB delivery and the use of a variety of targets and ion source: (1) The first target station could be dedicated to conventional targets and ion sources similar to those used at ISOLDE. (2) The second station could house both laser- and surface ion sources because they are mechanically similar. (3) The third station could be designed specifically for targets coupled to ECR sources. In addition, two separators are foreseen: (1) a general-purpose separator (GPS) for the ECR source operating at a constant E/μ of 10 keV/μ and (2) a high-resolution separator (HRS) for the first two stations operating with a constant ion energy of ~100 keV. The first RFQ would only be needed for the HRS branch to boost the energy from 1 or 2 keV/μ to ~10 keV/μ.

7254 (CONF-9210121–, pp. 353-356) **The "Charge State Enforcer" revisited.** Loebner, K.E.G. (Universitaet Muenchen, Garching (Germany)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

This paper looks at two physical problems associated with the suggested Charge State Enforcer concept, which is a suggested idea for increasing the efficiency of electron stripping of ions between acceleration stages in accelerator facilities. In installations with coupled accelerators, the second accelerator often uses higher charge state ions. This is generally accomplished by passing the ion beam through a thin carbon foil, and selecting one of the emerging charge states for further acceleration. For radioactive ion beams, where there are barely enough ions to begin, the losses associated with a conventional stripping process may prove unacceptable. However, there are problems associated with trying to implement the general idea of the charge state enforcer for recirculating ions of the wrong charge state back through the stripping process. Two of those are problems associated with energy loss in the stripping process and small angle scattering. The author looks at these two problems in regard to using 3 $\mu g/cm^2$ C foils for stripping, and also considers the possible use of gas strippers. Gas stippers suffer from the emerging charge state distribution being much lower than from solid foils.

7255 (CONF-9210121–, pp. 359-362) **Magnetic ring for stripping enhancement.** Selph, F. (Lawrence Berkeley Lab., CA (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. DOE Contract AC03-76SF00098. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

A ring designed to recycle ions through a stripping medium offers the possibility for increasing output of the desired charge state by up to 4x. This could be a very important component of a Radioactive Nuclear Beam Facility. In order for such a ring to work effectively it must satisfy certain design conditions. These include a chromaticity at the stripper, a dispersed region for an extraction magnet, and a number of first and higher order optics constraints which are necessary to insure that the beam emittance is not degraded unduly by the ring. An example is given of a candidate design of a stripping ring.

7256 (CONF-9210121–, pp. 363-367) **Air core superconducting cyclotrons and production of RNBs.** Subotic, K. (Institute of Nuclear Science Vinca, Beograd (Yugoslavia)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

This paper discusses the use of an air core superconducting cyclotron as the accelerator in a radioactive ion beam facility. This type of accelerator would allow great flexibility in coupling ion sources to it, and could have a facility which allows the use of both thin and thick target sources. In addition it would allow the use of the primary proton and/or ion beams. The paper only summarizes the main features of this type of an accelerator.

7257 (CONF-9210121–, pp. 369-372) **Accelerator complex for unstable beams at INS.** Tomizawa, M. (Univ. of Tokyo, Midoricho, Tanashi-shi, Tokyo (Japan)); Arai, S.; Doi, M.; Katayama, T.; Niki, K.; Tokuda, N.; Yoshizawa, M. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak

Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

The construction of the prototype facility of the Exotic-arena in proposed Japan Hadron Project (JHP) started in 1992 at INS. The purpose of this facility is to study various technical problems of the Exotic-arena and to perform experiments with respect to nuclear and astro-physics with unstable nuclei beam. The prototype facility will be constructed in the existing building at the present INS campus. Unstable nuclei produced by bombarding a thick target with 40 MeV proton beam (~10 μA) from the existing SF cyclotron are ionized in the ion sources (positive surface ionization, ECR or FEBIAD type), mass-analyzed by an ISOL (M/ΔM~5000), and transported to the following accelerator complex. The accelerator complex consists of an SCRFQ (split coaxial RFQ) and an IH (interdigital H type) linac. Unstable nuclei from the ISOL with an energy of 2 keV/u and a charge-to-mass ratio (q/M) greater than 1/30 are accelerated up to 170 keV/u by the SCRFQ. the beam is charge-exchanged by a stripper up to a q/M greater than 1/10, and is further accelerated up to 1 MeV/u by the IH linac. The output energy is variable over a range from 170 keV/u to 1 MeV/u by tuning the rf power and phase fed into the IH linac. The construction of the accelerators will be completed during the fiscal year 1994. In this paper, the present status of the accelerator complex is described with emphasis on a design of the IH linac.

7258 (CONF-9210121–, pp. 375-415) **The ORNL radioactive ion beam project.** Olsen, D.K. (Oak Ridge National Lab., TN (United States)); Alton, G.D.; Auble, R.L.; Baktash, C.; Dowling, D.T.; Garrett, J.D.; Haynes, D.L.; Jones, C.M.; Juras, R.C.; Lane, S.N.; Meigs, M.J.; Mills, G.D.; Mosko, S.W.; Robinson, R.L.; Tatum, B.A.; Blosser,Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. DOE Contract AC05-84OR21400. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

On June 30, 1992, the Holifield Heavy Ion Research Facility (HHIRF) was shut down as an operating national users' facility for heavy ion physics research and became a construction project to reconfigure the existing accelerator system and develop a first-generation radioactive ion beam (RIB) facility. During its 11 years of operation, the HHIRF had over 600 users, of which 200 were graduate students. During this time, nearly 39,000 hours of beam were delivered as beam-on-target for nuclear, atomic, and applied research. All together, 69 different isotopes from 36 different elements were accelerated for scheduled experiments. Most beams were produced with only the 25-MV tandem accelerator; however, for the most energetic beams and the heaviest ions, the Oak Ridge Isochronous Cyclotron (ORIC) was used as an energy booster. This paper will briefly review the concept of the ORNL RIB project and describe the progress being made on the various hardware components and physics factors required to produce RIBs with the HHIRF accelerator system.

7259 (CONF-9210121–, pp. 419-423) **Concluding remarks.** Casten, R.F. (Brookhaven National Lab., Upton, NY (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

This article is a brief set of concluding comments on the workshop. Many useful comments, new ideas, and much shared expertise was made available during this workshop, both in the presented talks, and in the workshop sessions where different aspects of the proposed project were discussed in depth. The paper stresses the need to assimilate this knowledge, to solicit more thought and input from the user and accelerator community, and to continue shaping the concept for this facility.

7260 (DOE/ER/40576–T1) **Readout electronics for a hybrid central tracking chamber: Final report.** Paulos, J.J. North Carolina State Univ., Raleigh, NC (United States). Dept. of Electrical and Computer Engineering. 13 Jul 1992. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AS05-90ER40576. Order Number DE94002766. Source: OSTI; NTIS; GPO Dep.

This is the Final Report for DOE Award No. DE-AS05-90ER40576, Readout Electronics for a Hybrid Central Tracking Chamber. This award is covered by the Memorandum of Understanding for FY 1990 between the Superconducting Super Collider Laboratory (SSCL) and the Hybrid Central Tracking Chamber (HCTC) Collaboration led by Dr. Alfred Goshaw at Duke University. Funding for FY 1990 was primarily intended to support research leading tb a proposal by the HCTC Collaboration to the DOE/SSCL SSC Detector Sub-System program in September of 1990. Recognizing that awards for FY 1991 funding might not be available until early 1991, the SSC Laboratory established a contract period of June 25, 1990 through June 9, 1991 for this award. The contract period was later extended through June 9, 1992 to allow completion of a subcontract to Oak Ridge National Laboratory (ORNL). The bulk of the work performed by North Carolina State University under this contract was completed by June 25, 1991. The primary thrust of the NCSU effort during this period was to evaluate the feasibility of using long (a meter) straw tubes in an SSC central tracking chamber. The feasibility of long straw tubes was established through a combination of transmission line simulations and experimentation on a 2.6 meter stack constructed at Duke University. NCSU was also responsible for the electrical design of an end plate board assembly to facilitate the use of the 2.6; meter stack in tracking studies. The PC boards were fabricated by ORNL under a subcontract to this award.

7261 (FNAL-TM–1832) **Overview of a robotic system for azimuthal dimensions of SSC dipole coils.** Assell, D.L. (and others); Cahill, J.M.; Carson, J.A. Fermi National Accelerator Lab., Batavia, IL (United States). Mar 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE94004652. Source: OSTI; NTIS; INIS; GPO Dep.

This system measures the azimuthal dimensions of SSC dipole long coils automatically, taking over 500 measurements in less than four hours. These measurements are then analyzed and displayed via software reports which reveal coil statistics, point by point dimensional graphics, modulus of elasticity measurements, comparisons with previous coils and pre-collaring shimming information. The rapid turnaround of this system yields the ability to spot process variables and fine tune the fabrication techniques. This process will aid in producing coils to the required precision.

7262 (FNAL-TM–1834) **Topics in radiation at accelerators: Radiation physics for personnel and environmental protection.** Cossairt, J.D. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 247p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE94004665. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the following topics: Composition of Accelerator Radiation Fields; Shielding of Electrons and Photons at Accelerators; Shielding of Hadrons at Accelerators; Low Energy Prompt Radiation Phenomena; Induced Radioactivity at Accelerators; Topics in Radiation Protection Instrumentation at Accelerators; and Accelerator Radiation Protection Program Elements.

7263 (FNAL-TM–1845) **Betatron stochastic cooling in the Debuncher: Present and future.** Visnjic, V. Fermi National Accelerator Lab., Batavia, IL (United States). Jul 1993. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE94004661. Source: OSTI; NTIS; INIS; GPO Dep.

A detailed study of the betatron stochastic cooling in the Debuncher is presented. First, a complete theoretical model including the emittance-dependent signal-to-noise ratio as well as time-dependent mixing is constructed. The emittance measurements in the Debuncher are described and it is shown that the model is in

excellent agreement with the experimental data. The idea of gain shaping is proposed and it is shown that the gain shaping would improve the cooling of the beam. Several proposals for future improvements are studied and appraised, in particular, gain shaping, ramped η, and cryogenic and "smart" pickups and kickers. Finally, the demands which the Main Injector will impose on the Debuncher are analyzed and a design of the betatron stochastic cooling system for the Main Injector era is outlined.

7264 (FNAL-TM–1861) **Energy losses in the D0 β solenoid cryostat caused by current changes.** Visser, A.T. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE94004632. Source: OSTI; NTIS; INIS; GPO Dep.

The proposed D0 β solenoid is a superconducting solenoid mounted inside an aluminum tube which supports the solenoid winding over it's full length. This aluminum support tube, also called bobbin, is therefore very tightly coupled to magnetic flux changes caused by solenoid current variations. These current changes in the solenoid, will cause answer currents to flow in the resistive bobbin wall and therefore cause heat losses. The insertion of an external dump resistor in the solenoid current loop reduces energy dissipation inside the cryostat during a quench and will shorten the discharge time constant. This note presents a simple electrical model for the coupled bobbin and solenoid and makes it easier to understand the circuit behavior and losses. Estimates for the maximum allowable rate of solenoid current changes, based on the maximum permissible rate of losses can be made using this model.

7265 (FNAL-TM–1869) **An overview of plastic optical fiber end finishers at Fermilab.** Mishina, M.; Lindenmeyer, C.; Korienek, J. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE94004657. Source: OSTI; NTIS; GPO Dep.

Several years ago the need for equipment to precisely finish the ends of plastic optical fibers was recognized. Many high energy physics experiments use thousands of these fibers which must be polished on one or both ends. A fast, easy-to-operate machine yielding repeatable finishes was needed. Three types of machines were designed and constructed that are in daily use at Fermilab, all finish the fiber ends by flycutting with a diamond tool. Although diamond flycutting of plastic is not new, the size and fragility of plastic optical fibers present several challenges.

7266 (IFVE-ORI–92-148) **Irradiation of beam extraction equipment of the IHEP proton synchrotron: Part 2. Work with high intensity.** Aseev, A.A.; Borodin, V.E. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1992. 11p. (In Russian). Order Number DE94610748. Source: OSTI; NTIS (US Sales Only); INIS.

The influence of the beam fast extraction on the slow extraction system septum-magnets irradiation is shown. The real meanings of beam extracting efficiency from U-70 are given. The proposals on lowering the radiating loadings on the equipment are presented. 16 refs.; 5 figs.

7267 (INIS-mf–13762) **The spallation neutron source SINQ: A new large facility for the research at PSI.** Bauer, G.S. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). No corporate text available. Dec 1992. 45p. (In German). Order Number DE94610752. Source: OSTI; NTIS (US Sales Only); INIS.

In the present document, the principles of neutron scattering and its many applications are brought closer to the reader interested in science and technology with regard to the SINQ project of the PSI, and also the principle of operation, the design concept and some technical devices of the spallation neutron source are presented. 27 figs.

7268 (IPP–4/259) **Offset steering in multiamp ion sources - revisited.** Ott, W. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany). Jan 1993. 15p. Order Number DE94734074. Source: OSTI; NTIS (US Sales Only); INIS.

Steering of the individual beamlets in multiamp ion beams by offsetting the axes of circular extraction holes in three-electrode acceleration systems is revisited. A consistent application of the Langmuir-Blodgett theory of a spherical diode gives a stronger deflection per unit offset than assumed hitherto. (orig.)

7269 (LBL–33440) **Recent developments in cabling technology used to manufacture superconducting accelerator magnets.** Royet, J.; Scanlan, R.M. Lawrence Berkeley Lab., CA (United States). 20 Sep 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (SC-MAG–418; CONF-930926–24: 13. international conference on magnet technology, Victoria (Canada), 20-24 Sep 1993). Order Number DE94003259. Source: OSTI; NTIS; GPO Dep.

The cable is the heart of superconducting accelerator magnets. Since the initial development of the Rutherford cable, more than twenty years ago, many improvements in manufacturing techniques have increased the current carrying capacity. An experimental cabling machine was designed and constructed at LBL in 1984.

7270 (LBL–34603) **Improved measurement accuracy in a Long Trace Profiler: Compensation for laser pointing instability.** Irick, S.C. Lawrence Berkeley Lab., CA (United States). 2 Aug 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-930824–27: Synchrotron radiation instrumentation, Gaithersburg, MD (United States), 23-26 Aug 1993). Order Number DE94003408. Source: OSTI; NTIS; INIS; GPO Dep.

Laser pointing instability adds to the error of slope measurements taken with the Long Trace Profiler (LTP). As with carriage pitch error, this laser pointing error must be accounted for and subtracted from the surface under test (SUT) slope measurement. In the past, a separate reference beam (REF) allowed characterization of the component of slope error from carriage pitch. However, the component of slope error from laser pointing manifests itself differently in the SUT measured slope. An analysis of angle error propagation is given, and the effect of these errors on measured slope is determined. Then a method is proposed for identifying these errors and subtracting them from the measured SUT slope function. Separate measurements of carriage pitch and laser pointing instability isolate these effects, so that the effectiveness of the error identification algorithm may be demonstrated.

7271 (LBL–34670) **Water-cooled ion-milled diffraction gratings for the synchrotron radiation community.** McKinney, W.R.; Shannon, C.L.; Shults, E.N. Lawrence Berkeley Lab., CA (United States). Aug 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-930824–24: Synchrotron radiation instrumentation, Gaithersburg, MD (United States), 23-26 Aug 1993). Order Number DE94003419. Source: OSTI; NTIS; INIS; GPO Dep.

Key technical and strategic choices are reviewed, leading to the fabrication method of ion-milled grating grooves for the monochromators at the Advanced Light Source (ALS) at Lawrence Berkeley Laboratory (LBL), and for other synchrotrons. Several laboratories and their industrial partners have joined to manufacture gratings with essentially theoretical performance. Metrology -data and theoretical comparisons are given for square wave profile grating samples ion-milled into electroless nickel surfaces. The extensive capabilities of Hughes Aircraft in grating manufacture are reviewed.

7272 (LBL–34730) **The use of diffraction efficiency theory in the design of soft x-ray monochromators.** Padmore, H.A. (Lawrence Berkeley Lab., CA (United States)); Martynov, V.; Hollis, K. Lawrence Berkeley Lab., CA (United States). 23 Aug 1993. 26p. Sponsored by USDOE, Washington, DC (United States);Science and Engineering Research Council, Swindon (United Kingdom). DOE Contract AC03-76SF00098. (CONF-930824–26: Synchrotron radiation instrumentation, Gaithersburg, MD (United States), 23-26 Aug 1993). Order Number DE94003420. Source: OSTI; NTIS; INIS; GPO Dep.

In general, the diffraction efficiency of gratings is limited by the constraints imposed by the type of geometry used to scan the photon energy. In the simplest example, the spherical grating monochromator (SGM), the deviation angle, the grating groove

width and depth and the groove density are all constrained by considerations of the maximum photon energy and the tuning range for individual gratings. We have examined the case in which these parameters are unconstrained, resulting in predictions of the ultimate performance of lamellar type gratings for groove densities from 300 to 2400 1/mm for gold and nickel coatings. The differential method of Neviere et al was used for modeling the behavior of the gratings and justification is presented for this by rigorous comparison with measurements. The implications of these results for future monochromators based on a variable included angle geometry are discussed.

7273 (LBL–34776) **Status report on the Advanced Light Source control system, 1993.** Young, J. (and others); Brown, W. Jr.; Cork, C. Lawrence Berkeley Lab., CA (United States). Oct 1993. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-931023–10: International conference on accelerator and large experimental control systems, Berlin (Germany), 18-22 Oct 1993). Order Number DE94004013. Source: OSTI; NTIS; INIS; GPO Dep.

The Advanced Light Source (ALS), under construction for the past seven years, has become operational. The accelerator has been successfully commissioned using a control system based on hundreds of controllers of our own design and high performance personal computers which are the operator interface. The first beamlines are being commissioned using a control system based on VME hardware and the Experimental Physics and Industrial Control System (EPICS) software. The two systems are being integrated, and this paper reports on the current work being done.

7274 (ORNL/FTR–4863) **Travel to England for information on the Daresbury Recoil Separator: Foreign trip report, November 10–21, 1993.** Smith, M.S. Oak Ridge National Lab., TN (United States). 1 Dec 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004461. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The Daresbury Recoil Separator is a research device located at the Nuclear Structure Facility in Daresbury Laboratory, Warrington, England. This device will be transferred to Oak Ridge National Laboratory in spring of 1994 for use in a new research program at the Holifield Radioactive Ion Beam Facility. This report summarizes information obtained on the device and on its impending transfer to and reassembly at Oak Ridge National Laboratory.

7275 **Single-bunch synchrotron shutter.** Norris, J.R.; Tang, Jau-Huei; Chen, Lin; Thurnauer, M. To Dept. of Energy. 1991. U.S. patent application 7-762,966. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94003057. Source: OSTI; NTIS; INIS; GPO Dep.

An apparatus for selecting a single synchrotron pulse from the millions of pulses provided per second from a synchrotron source includes a rotating spindle located in the path of the synchrotron pulses. The spindle has multiple faces of a highly reflective surface, and having a frequency of rotation f. A shutter is spaced from the spindle by a radius r, and has an open position and a closed position. The pulses from the synchrotron are reflected off the spindle to the shutter such that the speed s of the pulses at the shutter is governed by: $s=4 \times \pi \times r \times$ such that a single pulse is selected for transmission through an open position of the shutter.

7276 (SLAC-PUB–4252) **Beamstrahlung monitors at SLC.** Field, R.C. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Mar 1987. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-8703128–11: International conference on advances in experimental methods for colliding beam physics, Stanford, CA (United States), 9-13 Mar 1987). Order Number DE94003464. Source: OSTI; NTIS; GPO Dep.

Some properties of beamstrahlung are discussed, and plans to observe the effect at SLC by the use of Cherenkov counters are illustrated.

7277 (SLAC-PUB–5983) **Survey and alignment of high energy physics accelerators and transport lines.** Ruland, R.E. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Nov 1992. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9211278–1: American Society of Civil Engineers (ASCE) specialty conference on engineering survey for mega project-with-focus on SSC, Dallas, TX (United States), 10-14 Nov 1992). Order Number DE94003460. Source: OSTI; NTIS; INIS; GPO Dep.

This talk summarizes the survey and alignment processes of accelerators and transport lines and discusses the propagation of errors associated with these processes. The major geodetic principles governing the survey and alignment measurement space are revisited and their relationship to a lattice coordinate system shown. The paper continues with a broad overview about the activities involved in the step by step sequence from initial absolute alignment to final smoothing. Emphasis is given to the relative alignment of components, in particular to the importance of incorporating methods to remove residual systematic effects in surveying and alignment operations.

7278 (SLAC-PUB–6167) **Study of non-linear photoemission effects in III-V semiconductors.** Tang, H. (and others); Alley, R.K.; Aoyagi, H. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Oct 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930511–495: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94003456. Source: OSTI; NTIS; INIS; GPO Dep.

Our experience at SLAC with photoemission-based polarized electron sources has shown that charge limit is an important phenomenon that may significantly limit the performance of a photocathode for applications requiring high intensity electron beams. In the process of developing high performance photocathodes for the ongoing and future SLC high energy physics programs, we have studied the various aspects of the charge limit phenomenon. We find that the charge limit effect arises as a result of non-linear response of a photocathode to high intensity light illumination. The size of the charge limit not only depends on the quantum efficiency of the cathode but also depends critically on the extraction electric field. In addition, we report the observation of charge oversaturation when the intensity of the incident light becomes too large.

7279 (SLAC-PUB–6194) **Overview of the Final Focus Test Beam alignment system.** Bressler, V.E.; Ruland, R.E.; Plouffe, D. Stanford Linear Accelerator Center, Menlo Park, CA (United States). May 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930511–496: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94003455. Source: OSTI; NTIS; INIS; GPO Dep.

The Final Focus Test Beam was conceived as a technological stepping stone on the way to the next linear collider. Nowhere is this more evident than with the alignment subsystems. Alignment tolerances for components prior to beam turn are almost an order of magnitude smaller than for previous projects at SLAC. Position monitoring systems which operate independent of the beam are employed to monitor motions of the components locally and globally with unprecedented precision. An overview of the FFTB alignment system is presented herein.

7280 (SLAC-PUB–6201) **An "NLC-style" short bunch length compressor in the SLAC linac.** Seeman, J.T.; Holtzapple, R. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930511–504: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94005239. Source: OSTI; NTIS; INIS; GPO Dep.

Experimental tests of a "second bunch length compressor" in a linac is important for the next generation of linear colliders and for other future accelerators. These future accelerators need bunches with lengths of order 0.06 – 0.2 mm. At these lengths, new accelerator dynamics will be encountered. We have studied the possibility of constructing a second compressor with the present SLAC linac and have found a reasonable design. The core of this project is to reconfigure an old beamline (BL-90) at the 1000m location in the linac to: (1) extract a 10 GeV bunch, (2) pass it

through a new 96 m long transport line in which length compression is done, and (3) reinject the beam into the main linac in an available drift section. Using the resulting compressed bunch, accelerator physics tests would be performed in the remaining downstream linac with the resulting very high charge density. The bunch compression in this transport line results from the TRANSPORT element R_{56} as determined from the optics of the transport line. $\Delta z = R_{56}\,\Delta E/E$. For example, if $\Delta z = -0.5$ mm, $\Delta E/E = 0.5\%$, $R_{56} = -0.1$ m, a bunch of 5×10^{10} particles would have a final length (σ_z) of about 0.08 mm with a peak current of 9600 Å.

7281 (SLAC-PUB–6203) **Length monitor for 1 mm SLC bunches.** Babenko, E.; Jobe, R.K.; McCormick, D.; Seeman, J.T. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930511–507: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94005237. Source: OSTI; NTIS; INIS; GPO Dep.

A non-intercepting RF bunch length monitor for $\sigma_z = 0.5$ to 2.0 mm long electron and positron bunches in the Stanford Linear Collider (SLC) has been built with a design similar to a previous device for longer bunches. For this device, fields from the beam pass through a ceramic gap, enter receiving cavities, are the measured with power detectors, and finally are recorded by the SLC control computer. The designs of the receiving cavities (25 and 36 GHz) are described as well as the choice of the RF power distribution and measuring systems. Beam measurements have been taken as a function of bunch compressor RF voltage, bunch intensity, and beam position. Long term bunch length measurements were recorded during SLC colliding beam operation indicating that the bunch length is constant to about 3%. Thus, 1 mm length monitors operating at 25 and 36 GHz have successfully monitored long term bunch length changes at the few percent level in the SLC.

7282 (SLAC-PUB–6262) **Energy efficient deQing for SLAC Klystron Modulators.** Nesterov, V.V.; Cassel, R.L. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1993. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930635–1: Conference on optical spectroscopic instrumentation and techniques, Albuquerque, NM (United States), 3-6 Jun 1993). Order Number DE94003452. Source: OSTI; NTIS; INIS; GPO Dep.

Two hundred and forty Klystron Modulator Stations at SLAC were converted to a new deQing circuit configuration. With the help of the new deQing circuit, the energy stored in a charging choke at the moment of deQing is no longer dissipated in a resistor but is being constantly returned to the power line. The design considerations and a circuit layout will be presented.

7283 (SLAC-PUB–6296) **Fast ion chambers for SLC.** McCormick, D. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jul 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930511–499: PAC '93: international particle accelerator conference, Washington, DC (United States), 17-20 May 1993). Order Number DE94003439. Source: OSTI; NTIS; INIS; GPO Dep.

Beam diagnostic ion chambers are used throughout the SLC to perform a variety of tasks including locating beam losses along the beam direction, determining localized losses from individual bunches in a multibunch beam, and detecting scattered particles from beam profile wire scanners where backgrounds are too high to use photomultiplier tubes. Construction and instrumentation of very fast ion chambers with pulse duration of less than 60ns are detailed. Long ion chambers referred to as PLIC (Panofsky's Long Ion Chamber) are the primary diagnostic used to locate losses in all the SLC transport lines. Accurately locating beam loss with the use of fiducial cables and coaxial switches will be discussed.

7284 (SLAC-PUB–6380) **Experimental studies of the charge limit phenomenon in GaAs photocathodes.** Tang, H.; Alley, R.; Aoyagi, H.; Clendenin, J.; Saez, P.; Schultz, D.; Turner, J. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Oct 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9309288–1: Workshop on photocathodes for polarized electron sources for accelerators, Stanford, CA (United States), 8-10 Sep 1993). Order Number DE94003447. Source: OSTI; NTIS; INIS; GPO Dep.

GaAs photocathodes have been in use for generating high intensity polarized electron beams (up to a peak current of 6 A in 2 ns pulses) for the SLC high energy physics program. If the quantum efficiency (measured at low light intensities) of a GaAs photocathode is below a certain level, the maximum photoemitted charge is found to be limited by the intrinsic properties of the cathode instead of by the space charge limit. We have studied this charge limit phenomenon in a variety of GaAs photocathodes. The effects of the quantum efficiency, excitation laser wavelength, and extraction electric field on the charge limit have been examined. The temporal behavior of the charge limit as manifested in both intrapulse and interpulse effects has also been studied. These results will be discussed in light of possible mechanisms.

7285 (SLAC-PUB–6387) **A method of obtaining parasitic e^+ or e^- beams during SLAC linear collider operation.** Cavalli-Sforza, M. (California Univ., Santa Cruz, CA (United States). Inst. for Particle Physics); Kelley, L.A.; Klein, S.R. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Nov 1993. 4p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00515. NSF-PHY-9113428; NSF-PHY-9114958. (CONF-931107–31: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94005227. Source: OSTI; NTIS; INIS; GPO Dep.

We have developed a technique that allows SLAC to provide parasitic low-intensity secondary e^+ and e^- beams up to 25 GeV to End Stations A and B and to the FFTB during SLC operation. This beam was successfully used for a one-month-long experimental run in End Station A by the SLAC E-146 collaboration. The experiment used 400 MeV to 25 GeV electron beams at intensities averaging one electron per pulse and 120 pulses per second. The method for producing such a beam without the need for dedicated beam time was to operate parasitically from SLC: photons produced in the SLC beam scrapers in linac sectors 28, 29 and 30 were converted to positrons and electrons in a target downstream from the SLC splitter magnet. The secondary e^- (or e^+) were then transported to ESA with the A-line.

7286 (SSCL–651) **Interstrand resistance of selected sections of DCA312.** Kovachev, V. (Superconducting Super Collider Lab., Dallas, TX (United States)); Neal, M.; Seuntjens, J.; Qin, J.; Cline, P.; Capone, D. II; Swenson, C. Superconducting Super Collider Lab., Dallas, TX (United States). Nov 1993. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE94004273. Source: OSTI; NTIS; INIS; GPO Dep.

The quench current ramp rate sensitivity of the full length SSC dipole DCA312 was strongly A-type and the eddy current losses for this magnet were the largest of all ASST magnets. The quench current remained constant with ramp rate up to approximately 20 A/s. At higher ramp rates the quench current decreased dramatically. At a current ramp rate of 200 A/s the quench current was only 2000 A. The eddy current losses of DCA312 at 60 A/s for a monopolar cycle of 500A-5000A-500A were approximately 3600 J/Cycle, a factor of 5–7 larger than for magnets DCA311, DCA319, and DCA318. In order to find the cause of the anomalous behavior of DCA312, it was decided that the magnet would be cut into sections and examined at WMSD and SSCL. The general goals of the DCA312 autopsy included verification of theoretical models for A-type behavior in SSC magnets as well as correlation of fabrication and assembly procedures to the quench behavior of A-type magnets. One of the important aspects of the magnet autopsy plan was the in-situ measurement of interstrand resistance in collared magnet sections. Four sections of DCA312 were designated for interstrand resistance measurements. Two of those sections (C and M) contained quench sites (100 A/s and 200 A/s respectively) and two of them (E and J) were sections representative of the magnet where quenches did not occur. The aim of the present work was to measure and analyze the interstrand resistance in each quadrant of these four sections of DCA312 and to find a correlation between

the measured interstrand resistance, the actual resistance of individual interstrand contacts, and the quench performance of the magnet.

7287 (SSCL-Preprint–520) **Secondary particle in background levels and effects on detectors at future hadron colliders.** Pal, T. Superconducting Super Collider Lab., Dallas, TX (United States). Jun 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. (CONF-9306258–8: Workshop on B physics at hadron colliders, Snowmass, CO (United States), 21 Jun - 2 jul 1993). Order Number DE94003378. Source: OSTI; NTIS; INIS; GPO Dep.

The next generation of hadron colliders, the Superconducting Super Collider (SSC) and the Large Hadron Collider (LHC), will operate at high center-of-mass energies and luminosities. Namely, for the SSC (LHC) $\sqrt{s}$ = 40 TeV ($\sqrt{s}$ = 16 TeV) and L = 10^{33} $cm^{-2}s^{-1}$ (L = 3 x 10^{34} $cm^{-2}s^{-1}$). These conditions will result in the production of large backgrounds as well as radiation environments. Ascertaining the backgrounds, in terms of the production of secondary charged and neutral particles, and the radiation environments are important considerations for the detectors proposed for these colliders. An initial investigation of the radiation levels in the SSC detectors was undertaken by D. Groom and colleagues, in the context of the "task force on radiation levels in the SSC interaction regions." The method consisted essentially of an analytic approach, using standard descriptions of average events in conjunction with simulations of secondary processes. Following Groom's work, extensive Monte Carlo simulations were performed to address the issues of backgrounds and radiation environments for the GEM and SD C3 experiments proposed at the SSC, and for the ATLAS and CMS experiments planned for the LHC. The purpose of the present article is to give a brief summary of some aspects of the methods, assumptions, and calculations performed to date (principally for the SSC detectors), and to stress the relevance of such calculations to the detectors proposed for the study of B-physics in particular.

7288 (SSCL-SR–1228) **Development of accelerator radiation protection at the SSC.** Toohig, T. Superconducting Super Collider Lab., Dallas, TX (United States). Nov 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. Order Number DE94004274. Source: OSTI; NTIS; INIS; GPO Dep.

The design of the Superconducting Super Collider evolved over a series of studies from 1984 to 1989. Considerations of concentration of radiation sources and provisions for operational control and monitoring of radiation were determining elements in the design concepts for the facility. The development of the designs involved an extension of the range of applicability of energy deposition and radiation shielding codes beyond the 3 TeV level of the proposed UNK collider to 20 TeV for single beam effects and to 40 TeV in the collision regions. This extrapolation was complicated by the newly discovered, very energetic muons from short-lived states associated with heavy quark states. The design guideline for radiation protection was specified to be 10 mRem/yr, 10% of the Federal limit. In order to limit the amount of land required for the facility, which would extend over some 250 mi. sq., the configuration of the land to be acquired was tailored to the requirements for radiation containment below the levels of the guideline.

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Refer also to citation(s) 7255, 7612

7289 (ANL/XFD/CP–81399) **Apparent temperature versus true temperature of silicon crystals as a function of their thickness using infrared measurements.** Smither, R.K.; Fernandez, P.B. Argonne National Lab., IL (United States). [1993]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-930824–29: Synchrotron radiation instrumentation, Gaithersburg, MD (United States), 23-26 Aug 1993). Order Number DE94004616. Source: OSTI; NTIS; INIS; GPO Dep.

The very high intensity x-ray beams that will be present at the Advanced Photon Source and other third generation synchrotron sources will require that the first optical element in the beamline and, possibly, the second optical element as well, be cooled to remove the heat deposited by the x-ray beam. In many of the beamlines this heat will be in the 1 to 5 kW range, and any failure of the cooling system will require a quick response from safety control circuits to shut off the beam before damage is done to the optical element. In many cases, this first optical element will be a silicon diffraction crystal. Viewing the surface of objects subjected to high heat fluxes with an infrared camera or infrared sensor has proved to be a very effective method for monitoring the magnitude and distribution of surface temperatures on the object. This approach has been quite useful in studies of cooling silicon crystals in monochromators subject to high heat loads. The main drawback to this method is that single crystals of silicon are partially transparent to the infrared radiation monitored in most infrared cameras. This means that the infrared radiation emitted from the surface contains a component that comes from the interior of the crystal and that the intensity of the emitted radiation and thus the apparent temperature of the surface of the crystal depends on the thickness of the crystal and the kind of coating on the back (and/or the front) of the crystal. The apparent temperature of the crystal increases as the crystal is made thicker. A series of experiments were performed at Argonne National Laboratory to calibrate the apparent surface temperature of the crystal as measured with an infrared camera as a function of the crystal thickness and the type of coating (if any) on the back side of the crystal. A number of examples are given for data taken in synchrotron experiments with high intensity x-ray beams.

7290 (BUDKERINP–92-39) **Transverse vibrations of electron beam and ground motion measurements at VEPP-3 storage ring.** Lebedev, V.A.; Lebedev, P.K.; Parkhomchuk, V.V.; Shil'tsev, V.D. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1992. 13p. (IYaF–92-39.). Order Number DE94610767. Source: OSTI; NTIS (US Sales Only); INIS.

This paper is devoted to measurements of electron beam vibration at VEPP-3 storage ring. We measured simultaneously the beam vertical position by synchrotron radiation monitor, floor and magnetic quadrupole lens vibrations. The analysis of spectra of power and correlations points on strong connection of mechanical vibrations of lenses and beam movement at frequencies below 40 Hz and on definite influence of current supply fluctuations in the frequency range above hundred Hz. These results could be applied for design of various accelerator facilities such as SR sources, B-factories and large future colliders. 4 refs.; 8 figs.

7291 (CONF-9210121–, pp. 357) **Storage rings at ISL.** Moltz, D.M. (Lawrence Berkeley Lab., CA (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

The author discusses the application of a storage ring as a component of the ISL facility. The ring would have the advantage of relatively large luminosities for small beam intensities. It would also spread the background due to radioactive decay products over a very large area, decreasing this background problem. A storage ring is not the best mass measuring instrument however, and to operate it as such is to run it in an unstable mode. In addition to solving this particular problem, the mass measuring method, relying upon time of flight, requires fairly long cooling and purification times, and limits the application of the storage ring to isotopes with half lives greater than 1 second.

7292 (DESY–93-031) **Nonlinear canonical spin-orbit dynamics in storage rings: Normal forms and the vector n-axis.** Barber, D.P.; Heinemann, K.; Ripken, G. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Mar 1993. 63p. Order Number DE94734102. Source: OSTI; NTIS (US Sales Only); INIS.

The two real canonical spin variables α and β introduced in an earlier paper are combined with the six canonical variables of coupled synchro-betatron motion to form a system of eight canonical spin-orbit variables in which spin and orbital otion are treated on the same level. In these variables one turn maps are origin preserving and the usual techniques of canonical perturbation theory

can be applied. By writing the Hamiltonian in normal form the spin detuning terms as well as the so called vector n-axis which is needed in the theory of radiative polarization can be constructed. The equations derived are valid for arbitrary velocity of the particles (below and above transition energy). (orig.)

7293 (IFVE-OKU–92-145) **Electronuclear facility on the deuteron storage ring basis.** Ado, Yu.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij); Ufimtsev, A.G.; Korovin, Yu.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1992. 7p. (In Russian). Order Number DE94610768. Source: OSTI; NTIS (US Sales Only); INIS.

A high intensity neutron generator, which can be used as a basis of an electronuclear facility, is described. Generation of neutrons is a result of interaction of stores deutron beam with internal thin target. The target from matter with low atomic number Z is placed in the vacuum chamber of deutron storage ring. A choice of facility parameters can create such conditions that deutron losses from coulomb and nuclear scattering in the target are minimal and almost all of deutrons give us neutrons. 9 refs.; 2 figs.; 1 tab.

7294 (Juel–2735) **Installation and operation of a computer-controlled measuring assembly for dynamic measurements of dipole excitation cycles at COSY.** Stobik, V. Forschungszentrum Juelich GmbH (Germany). Inst. fuer Kernphysik. Feb 1993. 84p. (In German). Order Number DE94734007. Source: OSTI; NTIS (US Sales Only); INIS.

The field distribution during a dipole excitation cycle at COSY can be determined with an accuracy of 10^{-4} for the field value, and 10^{-5} for the current, with a time resolution down to 1 ms. The current values are measured with a zero-flow current transformer and a digital voltmeter. The field measurement is done with a stationary coil and a digital integrator without deadtime, with one absolute reference value being set by nuclear magnetic resonance measurement. The measuring process, the evaluation and the management of the data are controlled by a Unix computer and handled by a menu-guided, modular C program. (orig.)

7295 (LA-SUB–94-1) **Large Eddy Simulations using Lattice Boltzmann algorithms: Final report.** Serling, J.D. Los Alamos National Lab., NM (United States). 28 Sep 1993. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005666. Source: OSTI; NTIS; GPO Dep.

This report contains the results of a study performed to implement eddy-viscosity models for Large-Eddy-Simulations (LES) into Lattice Boltzmann (LB) algorithms for simulating fluid flows. This implementation requires modification of the LB method of simulating the incompressible Navier-Stokes equations to allow simulation of the filtered Navier-Stokes equations with some subgrid model for the Reynolds stress term. We demonstrate that the LB method can indeed be used for LES by simply locally adjusting the value of the BGK relaxation time to obtain the desired eddy-viscosity. Thus, many forms of eddy-viscosity models including the standard Smagorinsky model or the Dynamic model may be implemented using LB algorithms. Since underresolved LB simulations often lead to instability, the LES model actually serves to stabilize the method. An alternative method of ensuring stability is presented which requires that entropy increase during the collision step of the LB method. Thus, an alternative collision operator is locally applied if the entropy becomes too low. This stable LB method then acts as an LES scheme that effectively introduces its own eddy viscosity to damp short wavelength oscillations.

7296 (LBL–34556) **The PEP-II project: Design status and R&D results.** Zisman, M.S. (Lawrence Berkeley Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States); Stanford Linear Accelerator Center, Menlo Park, CA (United States); Lawrence Livermore National Lab., CA (United States). Jul 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098 ; AC03-76SF00515 ; W-7405-ENG-48. (CONF-9307143–5: 5. international symposium on heavy flavor physics, Montreal (Canada), 6-10 Jul 1993). Order Number DE94003988. Source: OSTI; NTIS; INIS; GPO Dep.

The PEP-II project, a joint proposal of SLAC, LBL, and LLNL, will involve an upgrade of the PEP storage ring at SLAC to serve as an asymmetric B factory. The upgrade will involve replacing the vacuum and rf systems of PEP, which will serve as the high-energy ring (containing 9 GeV electrons), along with the addition of a new low-energy ring (containing 3.1 GeV positrons) mounted atop the high-energy ring. The present design status of the project and a summary of recent R&D results are presented here. If approved, the PEP-II project is ready to begin construction in October 1993.

7297 (LBL-PUB–5379) **PEP-II: An asymmetric B factory: Conceptual design report.** Lawrence Berkeley Lab., CA (United States); Stanford Linear Accelerator Center, Menlo Park, CA (United States); California Inst. of Tech., Pasadena, CA (United States); Lawrence Livermore National Lab., CA (United States); California Univ., Berkeley, CA (United States). Intercampus Inst. for Research. Jun 1993. 641p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098 ; AC03-76SF00515 ; AC03-81ER40050 ; W-7405-ENG-48 ; AS03-76ER70285. (SLAC–418; CALT–68-1869; UCRL-ID–114055). Order Number DE94004812. Source: OSTI; NTIS; INIS; GPO Dep.

In this report, the authors have described an updated conceptual design for the high-luminosity Asymmetric B Factory (PEP-II) to be built in the PEP tunnel culmination of more than four years of effort aimed at the design and construction of an asymmetric e_+e_- collider capable of achieving a luminosity of $L = 3 \times 10^{33}\ cm^{-2}\ s^{-1}$. All aspects of the conceptual design were scrutinized in March 1991 by a DOE technical review committee chaired by Dr. L. Edward Temple. The design was deemed feasible and capable of achieving its physics goals. Furthermore, the cost estimate, schedule, and management plan for the project were fully endorsed by the committee. This updated conceptual design report captures the technical progress since the March 1991 review and reflects the lower cost estimate corresponding to the improved design. Although the PEP-II design has continued to evolve, no technical scope changes have been made that invalidate the conclusion of the DOE review. The configuration adopted utilizes two storage rings, an electron ring operating at 9 GeV and a positron ring at 3.1 GeV, each with a circumference of 2200 m. The high-energy ring is an upgrade of the PEP storage ring at SLAC; all PEP magnets and most power supplies will be reused. The upgrade consists primarily of replacing the PEP vacuum chamber and RF system with newly designed versions optimized for the high-current environment of PEP-II. The low-energy ring will be newly constructed and will be situated atop the high-energy ring in the PEP tunnel. Utilities already installed in the PEP tunnel are largely sufficient to operate the two PEP-II storage rings.

44 INSTRUMENTATION

Refer also to citation(s) 6614, 6673

4401 Radiation Instrumentation

Refer also to citation(s) 6283, 6307, 6308, 6310, 6926, 7203, 7211, 7233, 7237, 7240, 7260, 7262, 7264, 7501, 7548, 7552, 7565, 7567, 7622, 7623, 7682, 7710, 7711, 7715, 7884

7298 (ANL-HEP-TR–93-90) **Selection and characterization of lead alloys for use in the SDC EM Calorimeter.** Nasiatka, J. Argonne National Lab., IL (United States). [1993]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94003715. Source: OSTI; NTIS; INIS; GPO Dep.

Lead, because of it's density and ductility, has been used by man for centuries for many things ranging from building materials, to piping; from electrical connections, to radiation shielding, and batteries. However, despite it's extensive and varied use, not much is really known about it's exact physical and structural properties except in a very rudimentary way. The SDC cast lead EM Calorimeter needs to take full advantage of all the properties that the lead alloy has to offer. Hence, a very thorough and detailed understanding of the properties of the lead-absorber structure must be obtained and controlled, so that the integrity of the calorimeter

is not compromised. This paper will attempt to detail a series of ongoing experiments used to characterize and define the properties of the Calcium-Tin-Lead alloys for use in the SDC cast lead electromagnetic calorimeter.

7299 (ANL-HEP-TR–93-100) **Proposal for the completion of outstanding work on the mechanical absorber structure of SDC barrel electromagnetic calorimeter.** Guarino, V. (Argonne National Lab., IL (United States)); Hill, N.; Kicmal, T.; Nasiatka, J.; Petereit, E.; Price, L.; Proudfoot, J.; Stanek, R.; Scherbarth, D. Argonne National Lab., IL (United States). 17 Nov 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94004580. Source: OSTI; NTIS; INIS; GPO Dep.

The High Energy Physics Division at Argonne National Laboratory and Westinghouse Science and Technology Center, Pittsburgh Pennsylvania have worked jointly on a scintillating tile/fiber calorimeter with the SDC collaboration since it's inception in 1989. During the design and prototyping phase of the last three years, we have particularly worked on the development of an innovative cast lead approach to the absorber and the associated design of tile/fiber packaging for the barrel electromagnetic calorimeter (EMC). A full scale prototype program was initiated in 1992 to construct four EMC castings to be mated to respective steel hadronic wedges fabricated in China and presently at Fermilab. This proposal we outline in detail both the tasks that we have completed and those that we propose to complete in order to make the extensive investment in this technology useful to others in the field.

7300 (ANL/XFD/CP–80819) **Fast photoconductor CdTe detectors for synchrotron x-ray studies.** Yoo, Sung Shik (Illinois Univ., Chicago, IL (United States). Dept. of Physics); Faurie, J.P.; Wang, Kemei; Montano, P.A.; Huang Qiang; Rodricks, B. Argonne National Lab., IL (United States). Sep 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9309256–3: 3. London conference on position-sensitive detectors, London (United Kingdom), 6-10 Sep 1993). Order Number DE94001334. Source: OSTI; NTIS; INIS; GPO Dep.

The Advanced Photon Source will be that brightest source of synchrotron x-rays when it becomes operational in 1996. During normal operation, the ring will be filled with 20 bunches of positrons with an interbunch spacing of 177 ns and a bunch width of 119 ps. To perform experiments with x-rays generated by positrons on these time scales one needs extremely high speed detectors. To achieve the necessary high speed, we are developing MBE-grown CdTe-base photoconductive position sensitive array detectors. The arrays fabricated have 64 pixels with a gap of 100 μm between pixels. The high speed response of the devices was tested using a short pulse laser. X-ray static measurements were performed using an x-ray tube and synchrotron radiation to study the device's response to flux and wavelength changes. This paper presents the response of the devices to some of these tests and discusses different physics aspects to be considered when designing high speed detectors.

7301 (BfS-ST–5/93) **Quality assurance of dose rate measurements in the natural radiation field.** Sarenio, O.; Will, W. Bundesamt fuer Strahlenschutz, Berlin (Germany). Fachbereich Strahlenschutz. Sep 1993. 36p. (In German). Order Number DE94734045. Source: OSTI; NTIS (US Sales Only); INIS.

Several extensive measuring projects are carried out under the scientific direction of the Federal Office for Radiation Protection with the aim to register the radiological burdens due to former mining and to determine the natural radiation exposure in the new German states. For quality assurance in the measurement of gamma dose rates, comparisons were made of the calibration of predominantly used types of environmental gamma dose rate meters. To this end, the response of the measuring devices to different components of the natural radiation field was examined in the underground laboratory of the PTB Braunschweig and outdoors. Further studies were undertaken to check the calibration of 52 measuring instruments owned by contractor firms and regional measuring stations. From the results, it is obviously, that there are still fundamental shortcomings as to the quality assurance in the measurement of background radiation. (orig.)

7302 (DOE/ER/10629–T2) **Final technical information closeout for special research contract (SRC).** Oklahoma Univ., Norman, OK (United States). 1981. 47p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AS05-80ER10629. Order Number DE94004872. Source: OSTI; NTIS; GPO Dep.

This report describes the design of a magnetic spectrometer facility to be built in the Tagged Photon Lab. The design has been developed by a collaboration of physicists from Fermilab, The University of California at Santa Barbara, The University of Colorado and The University of Toronto. This group was formed to build the facility and to carry out the experiment described in Proposal 516, which is a study of photoproduced states (including charm and hidden charm) with a forward mass > 2.5 GeV. Although the design of the facility is developed from that outlined in P-516, much thought has gone into making the facility versatile enough to be used for a continuing program of physics by different groups. In addition to the 100 GeV photon physics of P-516, this facility is designed to be useful for experiments like the following: pion production experiments, hadron jet experiments, > 300 GeV and very high intensity photon physics with the energy doubler including searches for and studies of heavy leptons. The report goes into a detailed description of the various detectors which will be part of this detector system, and the experimental equipment which will be built.

7303 (DOE/ER/10629–T3) **Calculation of muon background.** Oklahoma Univ., Norman, OK (United States). [1982]. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AS05-80ER10629. Order Number DE94004873. Source: OSTI; NTIS; GPO Dep.

This progress report describes several projects that U of Oklahoma has participated in. The first is a muon background calculation from decay of charged pions and kaons, using ISR data at center of mass energies of 31 and 53 GeV. These calculations were compared with a number of different events. A copy of an agreement between Fermi National Accelerator Laboratory and participants in experiment E-653 is enclosed. This experiment tags charm and beauty particles by observing their decay lengths. The agreement sets out the items which need to be done in order to properly execute this experiment. A program to construct and test prototype silicon stripe detectors is also described. Preliminary detectors are in hand for testing, some are installed for actual beams for testing, and on the basis of these results the group expects to specify the design for a new system. The goals at present are to check charge collection, to check track point resolution, and to check vertex reconstruction resolution. A copy of a letter of intent to submit a proposal to LEP is included. The group proposes to submit a proposal to build an experiment with approximately 1% momentum resolution at 50 GeV/c for identifying photons, electrons, and muons. This proposal would aim at scalar particles, where accurate measures of small branching ratio decays are important. Some preliminary results from Monte Carlo simulation and data analysis of experiment E-516 are presented. In addition one group participant was involved in a CLEO experiment, which is an ongoing extension of work on a shower detector system. At present OU has the offline CLEO analysis software running and is supporting an effort with Rutgers to completer the inclusive electron measurements in the γ(4S) resonance region. This involves proper operation of the shower detector, and development of analysis software.

7304 (DOE/ER/10629–T5) **Beam solid state device (BSSD) performance in the test run June–July 1984.** Oklahoma Univ., Norman, OK (United States). [1984]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AS05-80ER10629. Order Number DE94004875. Source: OSTI; NTIS; GPO Dep.

This progress report describes U of Oklahoma participation in a number of detector development efforts. The first is a beam solid state device which was performance tested in runs during June and July, 1984. This was a partially instrumented test of an array of gridded solid state detectors. A beam drift chamber was also performance tested. This consist of 18 planes of 2 cells each. Each cell has drift distance of 18 mm on each side of the sense wire. Preliminary tests were also performed on a time-of-flight counter system. The system was not totally instrumented but resolution was able to be measured for its central section at least.

Tests showed a number of drifts which can be monitored and corrected. Test results were also collected for the hadron calorimeter for experiment E-653 at Fermilab.

7305 (DOE/ER/10629–T6) **Predicted performance of the multiplicity jump trigger.** Oklahoma Univ., Norman, OK (United States). [1986]. 132p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AS05-80ER10629. Order Number DE94004876. Source: OSTI; NTIS; GPO Dep.

This progress report presents information on a number of different projects worked on during the reporting period. One project is the design and performance of a multiplicity jump trigger. The prototype consist of an upstream interaction veto detector, a 3/16 inch long graphite target, a pair of before multiplicity detectors, a 1 inch decay region, and finally six after multiplicity detectors. All detectors were 300 micron thick silicon wafers with a 14 mm square active area. A tritium proportional chamber was built to check Simpson's result regarding evidence for a 17 keV massive neutrino seen in tritium decay. An electrostatic beta spectrograph has been constructed over the past five years. This detector will use hemispherical electrostatic fields to decelerate electrons from tritium beta decay. Integral endpoint spectra will be measured. The objective is to measure the electron antineutrino mass. A wide ranging theoretical program on non-perturbative quantum field theory work has been ongoing. The calculations which are being worked on involve both the electroweak and the strong interactions. In addition research work on a beam drift chamber, beam solid state detectors, and time-of-flight system are reviewed. A resistive plastic, proportional tube, gas hadron calorimeter with pad readout is described. Also the U of Oklahoma's High Energy Physics group has constructed, tested, and now is operating two SLAC 3081/E emulators, interfaced to a micro-Vax-2. Performance data from this system is described.

7306 (DOE/ER/10629–T7) **Considerations regarding "double-sided" solid state detectors.** Kalbfleisch, G.R.; Skubic, P. Oklahoma Univ., Norman, OK (United States). 2 Feb 1988. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AS05-80ER10629. Order Number DE94004877. Source: OSTI; NTIS; GPO Dep.

This progress report describes work ongoing at U of Oklahoma aimed at the development and utilization of double-sided solid state detectors. The devices are basically 300 μm thick silicon detectors, operated in a highly depleted mode. A particle passing through deposits approximately 90 keV of energy. This signal is read out from electrodes on one face. The authors are developing devices with readouts on both faces, which should allow better spatial resolution in multistripe detectors. If signal to noise ratios can be kept high, and noise levels made low enough, for detector preamplifier systems, then such detectors may be part of a B $\bar{B}$ collider proposal.

7307 (DOE/ER/10629–T8) **Status of tests of double-sided solid state multistripe detectors.** Skubic, P.L. (Univ. of Oklahoma, Norman, OK (United States). Physics and Astronomy Dept.); Kalbfleisch, G.R.; Lambrecht, M.A.; Wilburn, C.D. Oklahoma Univ., Norman, OK (United States). Dept. of Physics and Astronomy. 1988. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AS05-80ER10629. Order Number DE94004878. Source: OSTI; NTIS; GPO Dep.

Two double-sided multistripe silicon detectors purchased from Micron Semiconductor, Ltd. have been bench tested. The devices are 40 mm x 40 mm x 300 μm thick, with 40 stripes on each side, in directions orthogonal to each other. Interstripe resistances of 250 $\pm$ 100 kΩ were measured on the non-diode (ohmic) side when the detectors were fully depleted. A Sr^{90} source and charge sensitive amplifiers were used to measure charge correlations between orthogonal stripes on opposite sides of the detectors as a function of bias voltage. At a full depletion voltage of 42 V, the difference in pulse heights from opposite-side stripes gave a Gaussian distribution consistent with the amplifier noise, indicating that the detectors work well as two dimensional position sensitive devices.

7308 (DOE/ER/40452–9) **Research and development of a helium-4 based solar neutrino detector: Progress report, November 1, 1991–April 30, 1993.** Lanou, R.E.; Maris, H.J.; Seidel, G.M. Brown Univ., Providence, RI (United States). Dept. of Physics. May 1993. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER40452. Order Number DE94002417. Source: OSTI; NTIS; INIS; GPO Dep.

Superfluid helium possesses unique properties that enable it to be used as the major component of a very sensitive calorimetric detector: it is extremely pure, and the energy deposited in it is carried out by elementary excitations of the liquid which can produce quantum evaporation of He atoms at a free surface. It has a major advantage of being able to achieve very low background levels. Experimental results presented on the development of helium-4 detector include sensitivity, heat capacity of wafer-calorimeters, coincidence measurements, spectrum of alpha particles in helium, and quantum evaporation: angular dependence and efficiency. 29 refs., 16 figs., 1 tab.

7309 (DOE/ER/40503–T1) **[Silicon drift chamber studies for possible use at the relativistic heavy-ion collider]: Progress report.** Humanic, T.J. Pittsburgh Univ., PA (United States). Dept. of Physics. [1991]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER40503. Order Number DE93018898. Source: OSTI; NTIS; GPO Dep.

This is a progress report on the study of silicon drift-chambers at Brookhaven RHIC.

7310 (DOE/ER/40673–2) **SSC and G-2 calorimeter and optical calibration: Progress report, September 15, 1992–September 14, 1993.** Winn, D.R. Fairfield Univ., CT (United States). Nov 1993. 130p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER40673. Order Number DE94002901. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses: Task A: G-2 Photomultiplier & Calibration Systems (BNL E821) and Task B: Optical Calorimeter R&D & Calibration for High Rates & Colliders.

7311 (DOE/ER/40688–2) **Progress report of a research program in experimental and theoretical high energy physics, 1 June 1992–May 31, 1993.** Brandenberger, R. (and others); Cutts, D.; Fried, H.M. Brown Univ., Providence, RI (United States). Dept. of Physics. 1 Jun 1993. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER40688. Order Number DE94002156. Source: OSTI; NTIS; INIS; GPO Dep.

The main emphasis in the theoretical program has been in the area of string theory; also investigated were confinement and other aspects of QCD, electroweak symmetry breaking, and electroweak baryogenesis. The research program in computational physics concentrated on the development of the source Galerkin method of numerical quantum field theory. One portion of the experimental program dealt with interactions of leptons and hadrons from accelerator and strophysics sources. A description of the Large Volume Detector at Gran Sasso and its use as a stellar collapse monitor is given, along with an account of research and development on resistive plate counters. The rest of the experimental program concerns hadron collider and neutrino physics, with major emphasis on the D0 experiment at the TeVatron. The commissioning of the D0 detector and its operation are described, along with D0 analysis. Also reported is a novel cryogenic technique utilizing superfluid helium for neutrino calorimetry. 122 refs., 7 tabs., 23 figs.

7312 (DOE/ER/40787–1) **[Continuation request for E864 capital grant, FY 1994]: [Semiannual technical progress report, June 1, 1993–November 14, 1993].** Yale Univ., New Haven, CT (United States). [1993]. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-93ER40787. Order Number DE94001655. Source: OSTI; NTIS; GPO Dep.

This report discusses detector systems progress; AGS beam line and experiment layout; and schedule and budget information.

7313 (ETDE-IT–93-247) **Monte Carlo computed field parameters for design of photon personal dosemeters.** Fantuzzi, E. (ENEA, Bologna (Italy)); Gualdrini, G.F.; Morelli, B.; Monteventi, F. No corporate text available. 1993. 4p. (CONF-9304196–2: Austrian-Italian-Hungarian radiation protection symposium, Obergurgl (Austria), 28-30 Apr 1993). Order Number DE94727314. Source: OSTI; NTIS (US Sales Only).

The computed field parameters, collision kerma backscatter factor, backscattered radiation mean energy and their dependence on

radiation incident angle, as well as, the ICRU operational quantity directional dose equivalents H'(0.07, omega) H'(3, omega) and H'(10, omega) were computed for a spherical phantom composed of the tissue substitute material RS-1, which demonstrated its characteristics very similar to the ICRU theoretical material. The calculations were carried out with the Monte Carlo code MCNP (Monte Carlo for Neutrons and Photons). These data together with energy response experimental data allowed the optimization of the design procedure of personal dosemeters in terms of the new operational quantities as defined by ICRU 39-43 in the energy range from 20 to 1250 keV. The relationship between the dosemeter response and the quantity directional dose equivalent H'(d, omega), (where d is the depth in the phantom and omega is the incident angle) was expressed by a semi-empirical formula, based on the theoretically expected interaction of the dosemeter when placed on a suitable phantom with a photon beam of known spectrum, as well as, on the experimental energy response of the bare detector when irradiated in free air with reference photon beams. Moreover, the presence of filtration, could be taken into account to improve its performance through a term allowing for the beam attenuation. The Monte Carlo computed parameters allowed the solution of the semi-empirical formula and therefore the simulation of dosemeter response for each value of incidence angle and energy radiation in terms of H'(0.07, omega) or H'(10, omega) in the energy domain of interest.

7314 (ETDE-IT–93-250) **High dose dosimetry: Chemical and radiochromic methods.** Scarpa, G. (ENEA, Casaccia (Italy)). No corporate text available. 1992. 5p. (In Italian). (CONF-9211282–1: SIRR congress, Rome (Italy), 22 Nov 1992). Order Number DE94727364. Source: OSTI; NTIS (US Sales Only).

This paper reviews the state-of-the-art in pulsed radiation dosimetric techniques. A comparative analysis, based on test results from experiments conducted at the Casaccia research labs of ENEA (the Italian Agency for New Technology, Energy and the Environment), is made between the performance and reliability characteristics of ferrous-sulfate and clear perspex radiochromic effect dosimeters. Ample reference is made to the design basis of the classic chemical ferrous-ammoniacal sulfate dosimeter proposed by Hugo Fricke in 1927 and still considered, with respect to many aspects, to be a primary reference dosimeter, at least in the 40 to 400 Gy dose interval and for electron radiation in the range of 1 to 30 MeV.

7315 (EUR–14411, pp. 151-183) **Radon and radon daughters metrology: basic aspects.** Urban, M. (Kernforschungszentrum Karlsruhe GmbH (Germany)); Schmitz, J. Commission of the European Communities, Luxembourg (Luxembourg). 1993. In *Fifth International Symposium on the natural radiation environment.* 282p. Order Number DE94608870. Source: OSTI; NTIS (US Sales Only); INIS.

This paper describes the principles of measurement and devices used for the detection of radon gas: ionization chamber, scintillation method and double filter method. The second chapter shows the methods used for the detection of radon decay products: filter detector sampling for the measurement of aerosols or time integrating detectors (dosemeters, etching process, track counting, optical counting). In the third chapter, the problems of calibration, exposure assessment, uncertainty of the measurement, tests repeatability and reproducibility, influences of various etching parameters on the response for a given type of passive radon monitor using an electrochemically etched track detector are discussed. 30 refs., 6 tabs., 14 figs.

7316 (FNAL/C–93/290-E) **The CDF Silicon Vertex Detector.** Tkaczyk, S. (and others); Carter, H.; Flaugher, B. Stanford Linear Accelerator Center, Menlo Park, CA (United States). 1 Sep 1993. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9305267–2: International symposium on development and application of semiconductor tracking detectors, Hiroshima (Japan), 22-24 May 1993). Order Number DE94003620. Source: OSTI; NTIS; INIS; GPO Dep.

A silicon strip vertex detector was designed, constructed and commissioned at the CDF experiment at the Tevatron collider at Fermilab. The mechanical design of the detector, its cooling and monitoring are presented. The front end electronics employing a custom VLSI chip, the readout electronics and various components of the SVX system are described.

7317 (FNAL/C–93/302-E) **The CDF SVX II detector upgrade.** Skarha, J.E. (Johns Hopkins Univ., Baltimore, MD (United States). Dept. of Physics and Astronomy). Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9306176–17: Workshop on physics at current accelerators and the supercollider, Argonne, IL (United States), 2-5 Jun 1993). Order Number DE94003642. Source: OSTI; NTIS; INIS; GPO Dep.

The proposed CDF SVX II detector upgrade for secondary vertex detection during the Fermilab Tevatron Run II collider run is described. The general design and important features of this silicon vertex detector are presented. The CDF physics goals which are addressed by this detector are also given.

7318 (FNAL/C–93/318) **FASTBUS readout system for the CDF DAQ upgrade.** Andresen, J. (and others); Areti, H.; Black, D. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-931107–13: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94003644. Source: OSTI; NTIS; INIS; GPO Dep.

The Data Acquisition System (DAQ) at the Collider Detector at Fermilab is currently being upgraded to handle a minimum of 100 events/sec for an aggregate bandwidth that is at least 25 Mbytes/sec. The DAQ System is based on a commercial switching network that has interfaces to VME bus. The modules that readout the front end crates (FASTBUS and RABBIT) have to deliver the data to the VME bus based host adapters of the switch. This paper describes a readout system that has the required bandwidth while keeping the experiment dead time due to the readout to a minimum.

7319 (FNAL-TM–1865) **Radiation hardness of 3HF-tile/O2-WLS-fiber calorimeter.** Han, S.W. (Institute of High Energy Physics, Beijing, BJ (China)); Hu, L.D.; Liu, N.Z. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE94004631. Source: OSTI; NTIS; INIS; GPO Dep.

The radiation hardness of a 3HF-tile/O2-WLS-fiber calorimeter with two different tile/fiber patterns has been studied. Two calorimeter modules were irradiated up to 10 Mrad with the BEPC 1.3 GeV electron beam. The radiation damage of these modules is compared with our previous measurements from SCSN81-tile/BCF91A-WLS-fiber modules. The longitudinal damage profiles are fitted as a function of depth.

7320 (JINR-R–1-92-167) **The program for the simulation of experiments in deep inelastic scattering of leptons at the spectrometer STORS (GEATORS).** Akishin, P.G. (and others); Genchev, V.I.; Ivanov, V.V. Joint Inst. for Nuclear Research, Dubna (Russian Federation). 1992. 18p. (In Russian). Order Number DE94610903. Source: OSTI; NTIS (US Sales Only); INIS.

The program for the simulation of events in deep inelastic scattering of leptons at the superconducting toroidal spectrometer (STORS) is described. 6 refs.; 2 figs.

7321 (LA–12633-MS) **Directional measurements for sources of fission neutrons.** Byrd, R.C.; Auchampaugh, G.F.; Feldman, W.C. Los Alamos National Lab., NM (United States). Nov 1993. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94002888. Source: OSTI; NTIS; INIS; GPO Dep.

Although penetrating neutron and gamma-ray emissions arguably provide the most effective signals for locating sources of nuclear radiation, their relatively low fluxes make searching for radioactive materials a tedious process. Even assuming lightly shielded sources and detectors with large areas and high efficiencies, estimated counting times can exceed several minutes for source separations greater than ten meters. Because determining the source position requires measurements at several locations, each

with its own background, the search procedure can be lengthy and difficult to automate. Although directional measurements can be helpful, conventional collimation reduces count rates and increases the detector size and weight prohibitively, especially for neutron instruments. We describe an alternative approach for locating radiation sources that is based on the concept of a polarized radiation field. In this model, the presence of a source adds a directional component to the randomly oriented background radiation. The net direction of the local field indicates the source angle, and the magnitude provides an estimate of the distance to the source. The search detector is therefore seen as a device that responds to this polarized radiation field. Our proposed instrument simply substitutes segmented detectors for conventional single-element ones, so it requires little or no collimating material or additional weight. Attenuation across the detector creates differences in the count rates for opposite segments, whose ratios can be used to calculate the orthogonal components of the polarization vector. Although this approach is applicable to different types of radiation and detectors, in this report we demonstrate its use for sources of fission neutrons by using a prototype fast-neutron detector, which also provides background-corrected energy spectra for the incident neutrons.

7322 (LA–12666-M) **Research reactor fork users manual.** Hsue, S.T.; Menlove, H.O.; Bosler, G.E.; Dye, H.R.; Walton, G.; Halbig, J.K.; Siebelist, R. Los Alamos National Lab., NM (United States). Nov 1993. 48p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003171. Source: OSTI; NTIS; GPO Dep.

This manual describes the design features and operating characteristics of the research reactor fork. The system includes an ion chamber for gross gamma-ray counting, fission chambers for neutron counting, and a collimated high-resolution spectroscopy system for gamma-ray measurements. The neutron and ion chamber measurements are designed to be made underwater in spent-fuel cooling ponds. The neutron and gamma-ray detectors have been designed with high efficiencies to accommodate the relatively low emission rates of neutrons and gamma rays from low-burnup, research-type reactor fuel. This manual presents the design, performance, and test results for the system.

7323 (LA–12677-MS) **B-jet tagging using the GEM central tracker.** Brooks, M.L. Los Alamos National Lab., NM (United States). Jan 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005605. Source: OSTI; NTIS; INIS; GPO Dep.

The efficiency for tagging b-jets with the full GEM central tracker has been determined using a GEANT simulation to be approximately 35% for b-jets with $p_T > 50$ GeV/c while the fraction of other quark jets that are misidentified as b-jets is on the order of 1–3%.

7324 (LA–12678-MS) **Pattern recognition in the GEM central tracker at luminosity of 10^{33} $cm^{-2}s^{-1}$.** Brooks, M.L.; Kinnison, W.W. Los Alamos National Lab., NM (United States). Jan 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005604. Source: OSTI; NTIS; INIS; GPO Dep.

A GEANT based pattern recognition algorithm has been developed for simulations of the GEM central tracker. We describe the pattern recognition algorithm and present the results of studies of the track finding efficiency for single isolated tracks and for all tracks present in a Higgs event with minimum bias background at luminosity 10^{33} $cm^{-2}s^{-1}$.

7325 (LA–12679-MS) **Simulation of the GEM silicon central tracker using GEANT.** Brooks, M.L.; Kinnison, W.W. Los Alamos National Lab., NM (United States). Jan 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005606. Source: OSTI; NTIS; INIS; GPO Dep.

The silicon central tracker of the GEM detector has been simulated using the high energy physics simulations code GEANT. This paper will describe the level of detail of the geometry of the tracker that is in the code, including the silicon detectors themselves as well as all non-sensitive volumes such as support structures; the digitization, or detector response to particles, of the silicon detectors; the coordinate reconstruction from the digitizations, and some of the results of the simulations regarding the detector performance.

7326 (LA-UR–93-3528) **Prototype explosives detection system based on nuclear resonance absorption in nitrogen.** Morgado, R.E. (Los Alamos National Lab., NM (United States)); Arnone, G.; Cappiello, C.C.; Gardner, S.D.; Hollas, C.L.; Ussery, L.E.; White, J.M.; Zahrt, J.D.; Krauss, R.A. Los Alamos National Lab., NM (United States). [1993]. 12p. Sponsored by Federal Aviation Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9310164–7: International symposium on substance identification technologies, Innsbruck (Austria), 4-8 Oct 1993). Order Number DE94003979. Source: OSTI; NTIS; GPO Dep.

A-prototype explosives detection system that was developed for experimental evaluation of a nuclear resonance absorption techniques is described. The major subsystems are a proton accelerator and beam transport, high-temperature proton target, an airline-luggage tomographic inspection station, and an image-processing/detection- alarm subsystem. The detection system performance, based on a limited experimental test, is reported.

7327 (LA-UR–93-3588) **The effects of proton beam quality on the production of gamma rays for nuclear resonance absorption in nitrogen.** Morgado, R.E. (and others); Cappiello, C.C.; Dugan, M.P. Los Alamos National Lab., NM (United States). [1993]. 12p. Sponsored by Federal Aviation Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9310164–6: International symposium on substance identification technologies, Innsbruck (Austria), 4-8 Oct 1993). Order Number DE94003977. Source: OSTI; NTIS; GPO Dep.

We describe a method for performing nuclear resonance absorption with the proton beam from a radio frequency quadrupole (RFQ) linear accelerator. The objective was to assess the suitability of the pulsed beam from an RFQ to image nitrogen relative to that of electrostatic accelerators. This choice of accelerator results in tradeoffs in performance and complexity in return for the prospect of higher average current. In spite of a reduced resonance attenuation coefficient in nitrogen, we successfully produced three-dimensional tomographic images of real explosives in luggage the first time the unoptimized system was operated. The results and assessments of our initial laboratory measurements are reported.

7328 (LA-UR–93-3707) **Data acquisition system developed for the resonance absorption project.** Arnone, G.J.; Hollas, C.L. Los Alamos National Lab., NM (United States). [1993]. 5p. Sponsored by Federal Aviation Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931107–19: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94003973. Source: OSTI; NTIS; GPO Dep.

Minimizing signal errors and losses in high-rate gamma-ray imaging systems places demands on the signal-processing and data acquisition electronics. We will describe the data acquisition system developed for the resonance absorption project and techniques used to minimize dead-time and data losses. The data acquisition system acquires pulse-height spectra from an array of gamma-ray detectors and is made available to multiple processors by using the VMEbus standard to provide concurrent data analysis. A SUN workstation is used to develop the application software and also provides the user interface. We have developed a pulse-height-analysis board that has been optimized for low dead time. By incorporating an independent, high-speed signal channel for each detector, we are able to improve performance over multiplexed techniques.

7329 (LA-UR–93-3748) **Long-Range Alpha Detector (LRAD) sensitivity to beta contamination and soil moisture.** Johnson, J.D.; Allander, K.S.; Bounds, J.A.; Garner, S.E.; Johnson, J.P.; MacArthur, D.W. Los Alamos National Lab., NM (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931107–18: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94003972. Source: OSTI; NTIS; INIS; GPO Dep.

Long-Range Alpha Detector (LRAD) systems are designed to monitor alpha contamination by measuring the number of ions in the air. Alpha particles are a form of ionizing radiation and a typical 5-MeV alpha particle will create about 150,000 ion pairs in air. Recent tests have been performed to determine the sensitivity of LRAD systems to beta contamination and soil moisture levels. These results and the general technology are discussed in this paper.

7330 (LBL–33967) **Lithium drifted silicon detector fabrication on gettered Floating-Zone silicon.** Walton, J.T.; Wong, Y.K.; Derhacobian, N.; Haller, E.E. Lawrence Berkeley Lab., CA (United States). Nov 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-931107–15: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94003890. Source: OSTI; NTIS; GPO Dep.

A gettering procedure using phosphorus doped glass is shown to remove lithium-ion precipitation sites from p-type Floating-Zone (FZ) silicon. A model involving interaction between grown-in vacancies and oxidation-injected silicon interstitials is proposed to explain the gettering procedure. Examples of silicon lithium-drifted detectors fabricated on ungettered and gettered FZ silicons are presented.

7331 (LBL–33991) **GAMMASPHERE: Correction technique for detector charge trapping.** Goulding, F.S.; Landis, D.A. Lawrence Berkeley Lab., CA (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-931107–24: 1993 IEEE nuclear science symposium and medical imaging conference; Institute of Electrical and Electronic Engineers (IEEE) medical imaging conference, San Francisco, CA (United States); San Francisco, CA (United States), 2-5 Nov 1993; 4 Order Number DE94004554. Source: OSTI; NTIS; INIS; GPO Dep.

GAMMASPHERE uses 110 very large germanium detectors. Such detectors exhibit charge trapping effects on energy resolution initially due to a native electron trap that is present in virtually all germanium. Furthermore, radiation damage is a serious problem in GAMMASPHERE experiments, producing hole traps that degrade resolution and eventually require annealing to restore the original performance. The technique discussed here uses the current pulse shape from a detector to develop a parameter related to the radius of the largest interaction in the "track" of a gamma ray in the detector. Since the charge trapping loss in a signal can be related to the distance carriers travel, the "radius" parameter can be used by software to apply a trap correction to the signal.

7332 (LBL–33998) **Microstrip Gas Chambers on glass and ceramic substrates.** Gong, W.G.; Wieman, H.; Harris, J.W.; Mitchell, J.T.; Hong, W.S.; Perez-Mendez, V. Lawrence Berkeley Lab., CA (United States). Nov 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9311114–9: Institute of Electrical and Electronic Engineers (IEEE) medical imaging conference, San Francisco, CA (United States), 4-6 Nov 1993). Order Number DE94005207. Source: OSTI; NTIS; INIS; GPO Dep.

We report developments of Microstrip Gas Chambers (MSGC) fabricated on glass and ceramic substrates with various resistivities. Low resistivity of the substrate is found to be critical for achieving stable operation of microstrip gas chambers. The microstrip pattern consists of 10 μm wide anodes and 90 μm wide cathodes with a 200 μm anode-to-anode pitch. High-quality microstrips are fabricated using the dry etch after UV-photolithography. Our chambers are tested in an Ar(90)-CH_4(10) gas mixture at atmospheric pressure with a 100 μCi ^{55}Fe source. An energy resolution (FWHM) of 15% has been achieved for 6 keV soft X-rays. At a rate of 5 x 10^4 photons/sec/mm^2, gas gains are stable within a few percents. Long-term tests of gain stability and rate capability are yet to be pursued.

7333 (LBL–34022) **Determination of surface recombination velocity and bulk lifetime in detector grade silicon and germanium crystals.** Derhacobian, N.; Fine, P.; Walton, J.T.; Wong, Y.K.; Rossington, C.S.; Luke, P.N. Lawrence Berkeley Lab., CA (United States). Oct 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-931107–17: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94003886. Source: OSTI; NTIS; INIS; GPO Dep.

Utility of a noncontact photoconductive decay (PCD) technique is demonstrated in measuring bulk lifetime, τ_B, and surface recombination velocity, S, in detector grade silicon and germanium crystals. We show that the simple analytical equations which relate the observed effective lifetimes in PCD transients to τ_B and S have a limited range of applicability. The noncontact PCD technique is used to determine the effect of several surface treatments on the observed effective lifetimes in Si and Ge. A degradation of the effective lifetime in Si is reported as result of the growth of a thin layer of native oxide at room temperature under atmospheric conditions.

7334 (LBL–34663) **X-ray holographic microscopy using the atomic-force microscope.** Howells, M.R. (Lawrence Berkeley Lab., CA (United States)); Jacobsen, C.J.; Lindaas, S. Lawrence Berkeley Lab., CA (United States); State Univ. of New York, Stony Brook, NY (United States). Dept. of Physics. Sep 1993. 15p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098 ; FG02-89ER60858. Grant DIR-9006893. (CONF-9309290–1: 4. international conference on x-ray microscopy, Chenogolovka (Russian Federation), 20-24 Sep 1993). Order Number DE94004003. Source: OSTI; NTIS; INIS; GPO Dep.

The present authors have been seeking for some time to improve the resolution of holographic microscopy and have engaged in a continuing series of experiments using the X1A soft x-ray undulator beam line at Brookhaven. The principle strategy for pushing the resolution lower in these experiments has been the use of polymer resists as x-ray detectors and the primary goal has been to develop the technique to become useful for examining wet biological material. In the present paper the authors report on progress in the use of resist for high-spatial-resolution x-ray detection. This is the key step in in-line holography and the one which sets the ultimate limit to the image resolution. The actual recording has always been quite easy, given a high-brightness undulator source, but the difficult step was the readout of the recorded pattern. The authors describe in what follows how they have built a special instrument: an atomic force microscope (AFM) to read holograms recorded in resist. They report the technical reasons for building, rather than buying, such an instrument and they give details of the design and performance of the device. The authors also describe the first attempts to use the system for real holography and the authors show results of both recorded holograms and the corresponding reconstructed images. Finally, the authors try to analyze the effect that these advances are likely to have on the future prospects for success in applications of x-ray holography and the degree to which the other technical systems that are needed for such success are available or within reach.

7335 (LBL–34813) **Amorphous silicon pixel layers with cesium Iodide converters for medical radiography.** Jing, T. (Lawrence Berkeley Lab., CA (United States)); Cho, G.; Goodman, C.A. Lawrence Berkeley Lab., CA (United States). Nov 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-931107–16: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94003887. Source: OSTI; NTIS; INIS; GPO Dep.

We describe the properties of evaporated layers of Cesium Iodide (Thallium activated) deposited on substrates that enable easy coupling to amorphous silicon pixel arrays. The CsI(Tl) layers range in thickness from 65 to 220μm. We used the two-boat evaporator system to deposit CsI(Tl) layers. This system ensures the formation of the scintillator film with homogenous thallium concentration which is essential for optimizing the scintillation light emission efficiency. The Tl concentration was kept to 0.1–0.2 mole percent for the highest light output. Temperature annealing can affect the microstructure as well as light output of the CsI(Tl) film. 200–300C temperature annealing can increase the light output by a factor of two. The amorphous silicon pixel arrays are p-i-n diodes approximately lμm thick with transparent electrodes to enable them

to detect the scintillation light produced by X-rays incident on the CsI(Tl). Digital radiography requires a good spatial resolution. This is accomplished by making the detector pixel size less then 50μm. The light emission from the CsI(Tl) is collimated by techniques involving the deposition process on pattered substrates. We have measured MTF of greater than 12 line pairs per mm at the 10% level.

7336 (LBL–34832) **Potassium dihydrogen phosphate and potassium tantalate niobate pyroelectric materials and far-infrared detectors.** Baumann, H.B. (Lawrence Berkeley Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States). Oct 1993. 72p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract AC03-76SF00098. Contract A59513C. Order Number DE94004559. Source: OSTI; NTIS; GPO Dep.

This thesis discusses characterization of two ferroelectric materials and the fabrication of bolometers. Potassium tantalate niobate (KTN) and potassium dihydrogen phosphate (KDP) are chosen because they can be optimized for operation near 100K. Chap. 2 reviews the physics underlying pyroelectric materials and its subclass of ferroelectric materials. Aspects of pyroelectric detection are discussed in Chap. 3 including measurement circuit, noise sources, and effects of materials properties on pyroelectric response. Chap. 4 discusses materials selection and specific characteristics of KTN and KDP; Chap. 5 describes materials preparation; and Chap. 6 presents detector configuration and a thermal analysis of the pyroelectric detector. Electrical techniques used to characterize the materials and devices and results are discussed in Chap. 7 followed by conclusions on feasibility of KDP and KTN pyroelectric detectors in Chap. 8.

7337 (LBL–34899) **High efficiency neutron sensitive amorphous silicon pixel detectors.** Mireshghi, A.; Cho, G.; Drewery, J.S.; Hong, W.S.; Jing, T.; Lee, H.; Kaplan, S.N.; Perez-Mendez, V. Lawrence Berkeley Lab., CA (United States). Nov 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-931107–30: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94005208. Source: OSTI; NTIS; INIS; GPO Dep.

A multi-layer a-Si:H based thermal neutron detector was designed, fabricated and simulated by Monte Carlo method. The detector consists of two PECVD deposited a-Si:H pin detectors interfaced with coated layers of Gd, as a thermal neutron converter. Simulation results indicate that a detector consisting of 2 Gd films with thicknesses of 2 and 4 μm, sandwiched properly with two layers of sufficiently thick ($\sim$30μm) amorphous silicon diodes, has the optimum parameters. The detectors have an intrinsic efficiency of about 42% at a threshold setting of 7000 electrons, with an expected average signal size of $\sim$12000 electrons which is well above the noise. This efficiency will be further increased to nearly 63%, if we use Gd with 50% enrichment in ^{157}Gd. We can fabricate position sensitive detectors with spatial resolution of 300 μm with gamma sensitivity of $\sim 1 \times 10^{-5}$. These detectors are highly radiation resistant and are good candidates for use in various application, where high efficiency, high resolution, gamma insensitive position sensitive neutron detectors are needed.

7338 (NIIYaF-MGU–92-7-256) **Detection of 40-2000 MeV neutrons at the intensive gamma-ray background by means of a CsJ(Tl)-detector during the synchrotron U-70 experiment.** Antipov, A.V.; Belogorlov, E.A.; Bogomolov, A.V.; Britvich, G.I.; Kuptsov, S.I.; Lupenko, G.V.; Myagkova, I.N.; Ryumin, S.P.; Chumakov, A.A. Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1992. 24p. (In Russian). Order Number DE94610922. Source: OSTI; NTIS (US Sales Only): INIS.

Detector characteristics are investigated for solar neutron detection at cosmic stations. It is shown that usage of the identification method by the shape of scintillation flash is CsI(Tl) provides for reliable discrimination of neutron and γ-quanta in the studied energy range. Estimations are obtained for the identification efficiency of secondary protons and electrons in 13,5-80 MeV. The spectrum of isotopic composition of the products of neutron interaction with Cs and nuclei is estimated. Dependences are calculated of the neutron detection efficiency on the identification circuit threshold for space conditions. 14 refs.; 8 figs.; 1 tab.

7339 (NUREG/CR–6062) **Performance of portable radiation survey instruments.** Eisenhower, E. (Advanced Systems Technology, Inc., Atlanta, GA (United States)); Welch, L.; Wiblin, C. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Regulatory Applications; Advanced Systems Technology, Inc., Atlanta, GA (United States). Dec 1993. 26p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This report examines alleged and documented deficiencies in the performance and the calibration of existing portable radiation survey instruments. This report also examines a limited number of reported overexposures and excessive exposures attributed to instrumentation or calibration problems. The high failure rates in performance testing of a limited number of instruments indicate further testing is needed to demonstrate which instruments are acceptable and for what application. Further, the adequacy of calibration is not demonstrated at this time as many calibrations are performed by nonaccredited calibration laboratories. A review of the regulatory requirements and practices of the NRC and Agreement States regarding the use of existing performance standards such as ANSI N42-17A-1988 and the use of accredited calibration laboratories demonstrates that (1) the regulatory programs do not require compliance with existing industry standards; and (2) instruments are generally not required to be calibrated by accredited laboratories. Options are recommended that might encourage the use of industry performance standards and calibration techniques.

7340 (ORNL/FTR–4683) **Travel to Switzerland to perform data analysis, provide advice concerning the electromagnetic calorimeter level-1 power monitoring system, and particpate in the L3 experiment: Foreign trip report, June 14–30, 1993.** Read, K.F. Oak Ridge National Lab., TN (United States). 19 Jul 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE93018608. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The traveler's duties from June 15 to June 30, 1993, included performing L3 data analysis with emphasis on use of the electromagnetic calorimeter (BGO). The traveler worked with an L3 colleague to perform analysis concerning reconstruction of J/ψ and χ_c mesons. In addition, the traveler attended L3 meetings, both public and private, concerned with both hardware and software issues. The traveler provided advice concerning the BGO level-1 power and temperature monitoring system which the traveler had developed in previous years. The traveler served as L3 shift leader during his shifts and fulfilled his L3 shift allotment for the year. The traveler engaged in discussions to stay abreast of the status of developments of the proposed LHC collider and detectors at CERN.

7341 (PNL–8959) **Evaluation of the Science Applications International Corporation PD-4 electronic dosimeter.** Johnson, M.L. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004565. Source: OSTI; NTIS; INIS; GPO Dep.

The SAIC PD-4 electronic dosimeter was tested against the criteria given in ANSI N13.27 and for stability and angular response. Based on the results of the testing, the SAIC PD-4 electronic dosimeter is considered acceptable as a supplemental dosimeter for use at the Hanford Site with the following limitations. Though the dosimeter has a rate mode, it may not be used to establish worker dose rates. The dosimeter underresponds at high dose rates and may not be used in dose rate fields that exceed 600 R/h. The dosimeter also underresponds to photon energies less than 70 KeV and should not be used in areas where the external photon dose would be primarily from plutonium and its decay products. Because of the transmitter, the dosimeter has a relatively short battery life. The batteries should be replaced with fresh batteries by trained personnel each time the dosimeter is used (or once each day if used continuously). The requirement that an instrument be returned to the calibration facility for battery changes is waived for this instrument.

7342 (PNL-SA–22101) **Foreign criteria and programs.** Swinth, K.L. (Pacific Northwest Lab., Richland, WA (United States)); Thompson, I.M.G. Pacific Northwest Lab., Richland, WA (United States). Mar 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9303220–3: Workshop on measurement quality assurance for ionizing radiation, Washington, DC (United States), 16-18 Mar 1993). Order Number DE94004362. Source: OSTI; NTIS; INIS; GPO Dep.

The concept of measurement quality assurance (MQA) as embodied in National Institute of Standards and Technology (NIST) programs is not generally used within European programs for testing or accreditation. Although the essential elements of quality control and quality assurance are in the European programs, the concept of testing the capability of the laboratory itself, in terms of its performance for the designated measurements, may not be included. Rather, the European programs use the concept of periodic calibration of laboratory reference standards against the next highest level of standards. Thus, they embody the concept of measurement traceability to appropriate primary standards. Within Europe a series of calibration accreditation programs has been established in the various countries tied together through a multilateral agreement. The radiation measurement programs are based on the International Organization for Standardization (ISO) 9000 series of standards. The purpose of this paper is to outline the overall operation of European Accreditation Programs in the radiation calibration and measurement areas. The operation of the radiation measurement programs of the National Measurement Accreditation Service (NAMAS) in the United Kingdom is described in detail along with other European programs. The manner in which these programs relate to individual dosimetry service programs is also described.

7343 (PNL-SA–22411) **Monte Carlo calculations of low background detector response.** Miley, H.S. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931107–27: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94004593. Source: OSTI; NTIS; INIS; GPO Dep.

An implementation of the Electron Gamma Shower 4 code (EGS4) has been developed to allow convenient simulation of typical gamma ray measurement systems. Coincidence gamma rays, beta spectra, and angular correlations have been added to adequately simulate a complete nuclear decay and provide corrections to experimentally determined detector efficiencies. This code has been used to strip certain low-background spectra for the purpose of extremely low-level assay. Monte Carlo calculations of this sort can be extremely successful since low background detectors are usually free of significant contributions from poorly localized radiation sources, such as cosmic muons, secondary cosmic neutrons, and radioactive construction or shielding materials. Validation of this code has been obtained from a series of comparisons between measurements and blind calculations. The singles counting efficiency of a particular counting experiment was reproduced within the accuracy of the known dimensions of the detector components. This allowed the complete simulation of a nuclear decay, including two coincident gamma rays with a non-isotropic angular correlation. In addition, text-book efficiency curves have been reproduced for several sizes of sodium iodide detectors. Examples of the use and several spectral results are presented.

7344 (SLAC-PUB–5906) **Design and performance of the SLD Vertex Detector, a 120 Mpixel tracking system.** Agnew, G.D. (Brunel Univ., Uxbridge (United Kingdom)); Cotton, R.; Damerell, C.J.S. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Mar 1992. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-920837–46: ICHEP-26: 26th International Union of Pure and Applied Physics (IUPAP) conference on high energy physics, Dallas, TX (United States), 6-12 Aug 1992). Order Number DE94005241. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes the design, construction, and initial operation of the SLD Vertex Detector, the first device to employ charge coupled devices (CCDs) on a large scale in a high energy physics experiment. The Vertex Detector comprises 480 CCDs, with a total of 120 Mpixels. Each pixel functions as an independent particle detecting element, providing space point measurements of charged particle tracks with a typical precision of 5 μm in each co-ordinate. The CCDs are arranged in four concentric cylinders just outside the beam pipe which surrounds the e^+e^- collision point of the SLAC Linear Collider (SLC). The Vertex Detector is a powerful tool for distinguishing secondary vertex tracks, produced by decay in flight of heavy flavour hadrons or tau leptons, from tracks produced at the primary event vertex. Because the colliding beam environment imposes severe constraints on the design of such a detector, a six year R&D programme was needed to develop solutions to a number of problems. The requirements include a low-mass structure (to minimise multiple scattering) both for mechanical support and to provide signal paths for the CCDS; operation at low temperature with a high degree of mechanical stability; and relatively high speed CCD readout, signal processing, and data sparsification. The lessons learned through the long R&D period should be useful for the construction of large arrays of CCDs or smart pixel devices in the future, in a number of areas of science and technology.

7345 (SLAC-PUB–5970) **Performance of a silicon CCD pixel vertex detector in the SLD.** Strauss, M.G. (Massachusetts Univ., Amherst, MA (United States)). SLD Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Oct 1992. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-921122–67: Meeting of the Division of Particles and Fields of the American Physical Society, Batavia, IL (United States), 10-14 Nov 1992). Order Number DE94003461. Source: OSTI; NTIS; INIS; GPO Dep.

We present first results on the performance of a CCD based silicon vertex detector operated in 1992 in the SLC Large Detector (SLD) at the SLAC Linear Collider (SLC). A sample of 11K polarized Z^0 decays have been analyzed. Results on operational experience, alignment techniques, beam and detector backgrounds, and mechanical and thermal stability are presented. In conjunction with the central drift chamber, we present data on tracking and vertexing efficiency, and impact resolution for Z^0 events.

7346 (SLAC-PUB–6267) **Gamma Large Area Silicon Telescope (GLAST): Applying silicon strip detector technology to the detection of gamma rays in space.** Atwood, W.B. The GLAST Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Jun 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9305305–1: GLAST silicon detector conference, Hiroshima (Japan), 22-24 May 1993). Order Number DE94003451. Source: OSTI; NTIS; INIS; GPO Dep.

The recent discoveries and excitement generated by space satellite experiment EGRET (presently operating on Compton Gamma Ray Observatory – CGRO) have prompted an investigation into modern detector technologies for the next generation space based gamma ray telescopes. The GLAST proposal is based on silicon strip detectors as the "technology of choice" for space application: no consumables, no gas volume, robust (versus fragile), long lived, and self triggerable. The GLAST detector basically has two components: a tracking module preceding a calorimeter. The tracking module has planes of crossed strip (x,y) 300 μm pitch silicon detectors coupled to a thin radiator to measure the coordinates of converted electron-positron pairs. The gap between the layers (~5 cm) provides a lever arm for track fitting resulting in an angular resolution of $<0.1°$ at high energy. The status of this R & D effort is discussed including details on triggering the instrument, the organization of the detector electronics and readout, and work on computer simulations to model this instrument.

7347 (SLAC-PUB–6352) **A Full-Acceptance Detector (FAD) for the SSC: An Overview.** Bjorken, J.D. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Sep 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9306176–21: Workshop on physics at current accelerators and the supercollider, Argonne, IL (United States), 2-5 Jun 1993). Order Number DE94005232. Source: OSTI; NTIS; INIS; GPO Dep.

This status of the FAD initiative to provide a full-acceptance detector at the SSC is reviewed.

7348 (SLAC-PUB–6376) **CsI electromagnetic calorimeter development for a low or medium energy e^+e^- collider.** King, M.E. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9306276–1: 3. international workshop on a tau-charm factory, Marbella (Spain), 1-6 Jun 1993). Order Number DE94003448. Source: OSTI; NTIS; INIS; GPO Dep.

Design considerations for an electromagnetic CsI calorimeter suitable for use at low and medium energy, high-luminosity e^+e^- storage rings are presented, together with results of a test of an array of CsI(Tl) crystals in an e^-/π^- beam (120 to 400 MeV) at TRIUMF. The crystal array used in the test was designed to explore longitudinal and transverse crystal segmentation, and a redundant wavelength-shifter and photodiode readout system. Energy resolution of $(1.69 \pm 0.08)\%/\sqrt{E}$ and $(1.83 \pm 0.05)\%/\sqrt{E}$ was obtained for two different crystal tower configurations. Position resolution of 6.5 (9.0) mm was obtained at 300 (120)MeV for four 4×4 cm^2, 4 rl. CsI crystals.

7349 (SSCL-Preprint–516) **Real-time tracking with a 3D-Flow processor array.** Crosetto, D. Superconducting Super Collider Lab., Dallas, TX (United States). Jun 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. (CONF-9306258–14: Workshop on B physics at hadron colliders, Snowmass, CO (United States), 21 Jun - 2 jul 1993). Order Number DE94003981. Source: OSTI; NTIS; INIS; GPO Dep.

The problem of real-time track-finding has been performed to date with CAM (Content Addressable Memories) or with fast coincidence logic, because the processing scheme was thought to have much slower performance. Advances in technology together with a new architectural approach make it feasible to also explore the computing technique for real-time track finding thus giving the advantages of implementing algorithms that can find more parameters such as calculate the sagitta, curvature, pt, etc., with respect to the CAM approach. The report describes real-time track finding using new computing approach technique based on the 3D-Flow array processor system. This system consists of a fixed interconnection architecture scheme, allowing flexible algorithm implementation on a scalable platform. The 3D-Flow parallel processing system for track finding is scalable in size and performance by either increasing the number of processors, or increasing the speed or else the number of pipelined stages. The present article describes the conceptual idea and the design stage of the project.

7350 (SSCL-Preprint–535) **SDC tracking capabilities for B physics.** Coupal, D.P. Superconducting Super Collider Lab., Dallas, TX (United States). Jun 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC35-89ER40486. (CONF-9306258–13: Workshop on B physics at hadron colliders, Snowmass, CO (United States), 21 Jun - 2 jul 1993). Order Number DE94003590. Source: OSTI; NTIS; INIS; GPO Dep.

The $b\bar{b}$ production cross section is estimated to be 1 mb at $\sqrt{s}$ = 40 TeV, implying 10^{12} produced $b\bar{b}$ pairs at an SSC luminosity of $10^{32} cm^{-2} sec^{-1}$ (.1 x design). SDC has the potential to exploit this high rate to explore a-number of B physics topics, in particular, CP violation in the neutral B meson. This note describes the SDC particle tracking design and its predicted performance parameters relevant to B physics.

4402 Radiation Effects On Instrument Components, Instruments, Or Electronic Systems

Refer also to citation(s) 7287

4405 Thermal Instrumentation

Refer also to citation(s) 6482

4406 Optical Instrumentation

Refer also to citation(s) 6482, 7044, 7108, 7236, 7271, 7336, 7420, 7799, 7800

7351 (BNL–49632) **A step-height standard for surface profiler calibration.** Takacs, P.Z. (Brookhaven National Lab., Upton, NY (United States)); Li, M.X.O.; Furenlid, K.; Church, E.L. Brookhaven National Lab., Upton, NY (United States). Sep 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-930722–55: Annual meeting of the Society of Photo-Optical Instrumentation Engineers (SPIE), San Diego, CA (United States), 11-16 Jul 1993). Order Number DE94004948. Source: OSTI; NTIS; GPO Dep.

We report on the design and fabrication of an all-silicon test pattern that is very useful for assessing the performance of all types of profiling instruments. We present examples of results obtained from applying this method to various kinds of profiling instruments, including a WYKO TOPO 3D system, Microamp Promap 512 profilers, a ZYGO Maxim 3-D system, and scanning probe AFM systems. We also present the results from a measurement of the BRDF of the step with a TMA CASI scatterometer to show the utility of the step as a potential calibration standard for scattered light measuring instruments.

7352 (DOE/ER/61072–7) **The automated rotating shadowband spectroradiometer.** Harrison, L.; Beik, M.A.; Michalsky, J.J. State Univ. of New York, Albany, NY (United States). Atmospheric Sciences Research Center. [1993]. 4p. Sponsored by USDOE, Washington, DC (United States);New York State Energy Research and Development Authority, Albany, NY (United States). DOE Contract FG02-90ER61072 ; AC06-76RL01830. Grant 1725-EEED-IEA-92. (CONF-930346–5: Optical Society of America meeting on optical remote sensing of the atmosphere, Salt Lake City, UT (United States), 8-12 Mar 1993). Order Number DE94001878. Source: OSTI; NTIS; GPO Dep.

We are developing a photodiode array rotating shadowband spectroradiometer (RSS) as part of the Instrument Development Program (IDP) of the Atmospheric Radiation Measurement (ARM) Program of the United States Department of Energy (DOE). This instrument uses the automated rotating shadowband technique to separate and measure the spectrally resolved direct-normal, total horizontal, and diffuse horizontal irradiances in the 360 to 1060 nm wavelength region. It is intended as an instrument for the central facility of each of the cloud and radiation testbed (CART) sites, and will complement the array of multi-filter rotating shadowband radiometers (MFRSR) currently being deployed by ARM and other research programs including TOGA/COARE.

7353 (DOE/ER/61443–2) **Development of a multi-sensor in situ fiber optic fluorometer: Progress report, June 1, 1992–October 31, 1993.** Lohrenz, S.E. (University of Southern Mississippi, Stennis Space Center, MS (United States)); Asper, V.L.; Morris, M.J.; Walters, R.A. University of Southern Mississippi, Stennis Space Center, MS (United States). Nov 1993. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER61443. Order Number DE94003399. Source: OSTI; NTIS; GPO Dep.

Our objective is to develop and evaluate a multi-sensor in situ fiber optic fluorometer. The instruments is designed to sample and store in vivo strobe-stimulated fluorescence data at multiple depths and high frequencies (1 Hz). This information may be used for estimating the distribution and abundance of particulate pigment biomass, for supporting models of water column primary production and as a complement to remotely sensed ocean color estimates of pigment biomass. The instrument is unique in that it uses fiber optic technology to increase vertical resolution. While it is theoretically possible to accomplish this task using a large number of commercially available fluorometers, our proposed design would provide a less expensive approach. Two prototype instruments have been built and are being tested. The first, a single sensor instrument interfaced with a 486 personal computer, has been used to optimize hardware and sensor design and to evaluate fiber performance an instrument detection limits. The second instrument, containing 8 sensors and capable of autonomous operation with time-series data acquisition and storage, was recently deployed in a cruise in the Gulf of Mexico. Preliminary results indicate that the instrument meets all the project goals and that low cost, high frequency, high spatial resolution fluorescence data are obtainable with the current

design. Additional work will focus on further optimization of hardware design and software algorithms, and construction of an additional instrument specifically designed for deployement in the benthic boundary layer.

7354 (FNAL/C–93/339) **Distributing functionality in the Drift Scan Camera System.** Nicinski, T.; Constanta-Fanourakis, P.; MacKinnon, B.; Petravick, D.; Pluquet, C.; Rechenmacher, R.; Sergey, G. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9310239–1: 3. annual conference on astronomical data analysis software and systems, Victoria (Canada), 13-15 Oct 1993). Order Number DE94003640. Source: OSTI; NTIS; INIS; GPO Dep.

The Drift Scan Camera (DSC) System acquires image data from a CCD camera. The DSC is divided physically into two subsystems which are tightly coupled to each other. Functionality is split between these two subsystems: the front-end performs data acquisition while the host subsystem performs near real-time data analysis and control. Yet, through the use of backplane-based Remote Procedure Calls, the feel of one coherent system is preserved. Observers can control data acquisition, archiving to tape, and other functions from the host, but, the front-end can accept these same commands and operate independently. The DSC meets the needs for such robustness and cost-effective computing.

7355 (SAND–92-1107) **Inert strength of pristine silica glass fibers.** Smith, W.L.; Michalske, T.A. Sandia National Labs., Albuquerque, NM (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94004685. Source: OSTI; NTIS; GPO Dep.

Silica glass fibers have been produced and tested under ultra high vacuum (UHV) conditions to investigate the inert strength of pristine fibers in absence of reactive agents. Analysis of the coefficient of variation in diameter (v_d) vs the coefficient of variation of breaking strength (v_σ) does not adequately explain the variation of breaking stress. Distribution of fiber tensile strength data suggests that the inert strength of such fibers is not single valued and that the intrinsic strength is controlled by defects in the glass. Furthermore, comparison of room temperature UHV data with LN_2 data indicates that these intrinsic strengths are not temperature dependent.

7356 (SAND–92-1108) **The deposition of boron nitride and carbon films on silica glass fibers.** Smith, W.L.; Michalske, T.A.; Rye, R.R. Sandia National Labs., Albuquerque, NM (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94004684. Source: OSTI; NTIS; GPO Dep.

A chemical vapor deposition technique is used to produce amorphous boron nitride and carbon thin films on high strength silica glass fibers. In this method, the fiber is drawn under ultra high vacuum conditions and low pressure process gases, in the presence of a hot tungsten filament, are used to grow films at low substrate temperatures. Films deposited with this technique do not degrade the intrinsic pristine strength of the silica fibers under dry conditions and, when stressed in chemically aggressive environments, act as effective barrier coatings.

7357 (SAND–92-2909) **Holographic interferometry: A user's guide.** Griggs, D. Sandia National Labs., Albuquerque, NM (United States). Oct 1993. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94003136. Source: OSTI; NTIS; GPO Dep.

This manual describes the procedures and components necessary to produce a holographic interferogram of a flow field in the Sandia National Laboratories hypersonic wind tunnel. In contrast to classical interferometry, holographic interferometry records the amplitude and phase distribution of a lightwave passing through the flow field at some instant of time. This information can then be reconstructed outside the wind tunnel for visual analysis and digital processing, yielding precise characterizations of aerodynamic phenomena. The reconstruction and subsequent hologram image storage process is discussed, with particular attention paid to the digital image processor and the data reduction technique.

7358 (UCRL-JC–114506) **Characterization of physically vapor deposited AF2400 thin films.** Chow, R.; Spragge, M.K.; Loomis, G.E.; Rainer, F.; Ward, R.; Thomas, I.M.; Kozlowski, M.R. Lawrence Livermore National Lab., CA (United States). Nov 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-931108–13: Fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 29 Nov - 3 dec 1993). Order Number DE94004019. Source: OSTI; NTIS; GPO Dep.

Anti-reflective coatings made with Teflon AF2400 had the highest damage thresholds recorded for physical vapor deposited coatings at the Lawrence Livermore National Laboratory damage facility. Physical vapor deposited layers of Teflon AF2400, a perfluorinated amorphous polymer, maintained the bulk optical properties of a high transmittance from 200 nm to 1600 nm, and a low refractive index. In addition, the refractive index can be intentionally reduced by control of two common deposition parameters, deposition rate and substrate temperature. Scanning electron microscopy and nuclear magnetic resonance observations indicated that morphological changes caused the variations in the refractive index rather than compositional changes. The coatings adhered to fused silica and silicon wafers under normal laboratory handling conditions.

7359 (UCRL-JC–115309) **Modelling atmospheric turbulence effects on ground-based telescope systems.** Bradford, L.W. (California Univ., Santa Cruz, CA (United States). Dept. of Physics); Flatte, S.M.; Max, C.E. Lawrence Livermore National Lab., CA (United States). 30 Sep 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9306245–2: North Atlantic Treaty Organization/Advanced Study Institute (NATO/ASI) conference on adaptive optics for astronomy, Cargese (France), 29 Jun - 9 aug 1993). Order Number DE94004211. Source: OSTI; NTIS; GPO Dep.

Questions still exist concerning the appropriate model for turbulence- induced phase fluctuations seen in ground-based telescopes. Bester et al. used a particular observable (slope of the Allan variance) with an infrared interferometer in an attempt to distinguish models. The authors have calculated that observable for Kolmogorov and "random walk" models with a variety of outer scales and altitude-dependent turbulence and wind velocity. The authors have found that clear distinction between models requires good data on the vertical distribution of wind and turbulence. Furthermore, measurements at time separations of order 60 s are necessary to distinguish the "random walk" model from the Kolmogorov model.

4407 Geophysical and Meteorological Instrumentation

Refer also to citation(s) 6271

7360 (KFK–5068) **Investigations of a coherent vector radar technique for the observation of the atmosphere near 10 GHz.** Graebe, D. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Technische Physik. Dec 1992. 63p. (In German). Order Number DE94734012. Source: OSTI; NTIS (US Sales Only).

The radar measurement technique is used to an increasing degree for the investigation of the atmosphere. A novel measurement system was built on the basis of a vector network analyzer and its capability has been examined. The main feature of this system is the measurement technique, where the received signal will be analyzed for magnitude and phase. The subsequent fast Fourier transformation provides the representation of the radar echo over the delay time. To characterize the system parameters a reference line has been set up to a mast at a distance of approximately 700 m. First measurements have shown, that static targets with small radar cross sections are detectable. For typically weather appearance like clouds and rain the resolution limit will be shown. Consequences for the design of future measurement systems will be described. (orig.)

4408 Miscellaneous Instrumentation

Refer also to citation(s) 6051, 6111, 6159, 6488, 6883, 6951, 6998, 7092, 7166, 7270, 7334, 7481, 7519, 7554

7361 (CONF-9210121–, pp. 141-148) **Electromagnetic traps and radioactive ion beams.** Moore, R.B. (McGill Univ., Montreal, Quebec (Canada)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

This article provides a brief description of electromagnetic traps, used to confine charged particles. These devices are typically used by chemists and physicists today. Here the author considers an application at ISOLDE where two Penning traps are used together for high accuracy mass measurements. The first trap collects the radionuclides, and cools them, compressing their phase space volume. They are then transferred to a second trap, designed for precision measurements. Here the author reviews the basic operation of Penning and Paul (or radio-frequency quadrupole) traps, and touches on features of their operation.

7362 (CONF-9305134–, pp. 63-69) **Development of a dual-sinker densimeter for high-accuracy fluid P-V-T measurements.** McLinden, M.O. (National Institute of Standards and Technology, Boulder, CO (United States)); Frederick, N.V. Argonne National Lab., IL (United States). 1993. DOE Contract AI05-88ER13823. From 11. symposium on energy engineering sciences; Argonne, IL (United States); 3-5 May 1993. In *Eleventh symposium on energy engineering sciences: Proceedings: Solid mechanics and processing: Analysis, measurement and characterization.* 300p. Order Number DE93019930. Source: OSTI; NTIS; INIS; GPO Dep.

A dual-sinker densimeter to very accurately measure the pressure-volume-temperature (P-V-T) properties of fluids over a temperature range of 80 K to 520 K and at pressures up to 35 MPa is in the final stages of development at NIST. The density of a fluid is determined by measuring the difference in the buoyancy forces experienced by two sinkers of identical mass, surface area, and surface material, but very different volumes. The buoyancy forces on the sinkers are transmitted to a semi-microbalance by means of a magnetic suspension coupling. This paper reviews the principle of the measurement and describes the overall design of the system.

7363 (Y/DK–977) **Experimental and theoretical relative ion yields for glow discharge mass spectrometry.** Smithwick, R.W. III; Lynch, D.W.; Franklin, J.C. Oak Ridge National Lab., TN (United States). [1993]. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. (CONF-9305222–3: 41. American Society of Mass Spectrometry conference on mass spectrometry and allied topics, San Francisco, CA (United States), 30 May - 4 jun 1993). Order Number DE94003324. Source: OSTI; NTIS; GPO Dep.

Short communication. MASS SPECTROMETERS/yields; GLOW DISCHARGES/mass spectroscopy; YIELDS; IONIZATION

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

7364 (DPSZ–7890) **[Morgantown plant history for May 1944].** Du Pont de Nemours (E.I.) and Co., Aiken, SC (United States). 1944. 255p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–589). Order Number DE93015772. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This document provides the Morgantown Ordnance Works plant history as a part of the E. I. du Pont de Nemours & Company, Inc. Plant History Project.

7365 (SAND–93-1256C) **Risk-based methods applicable to ranking conceptual designs.** Breeding, R.J. (Sandia National Labs., Albuquerque, NM (United States)); Ortiz, K.; Ringland, J.T.; Lim, J.J. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–44: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94002920. Source: OSTI; NTIS; GPO Dep.

In Ginichi Taguchi's latest book on quality engineering, an emphasis is placed on robust design processes in which quality engineering techniques are brought "upstream," that is, they are utilized as early as possible, preferably in the conceptual design stage. This approach was used in a study of possible future safety system designs for weapons. As an experiment, a method was developed for using probabilistic risk analysis (PRA) techniques to rank conceptual designs for performance against a safety metric for ultimate incorporation into a Pugh matrix evaluation. This represents a high-level UW application of PRA methods to weapons. As with most conceptual designs, details of the implementation were not yet developed; many of the components had never been built, let alone tested. Therefore, our application of risk assessment methods was forced to be at such a high level that the entire evaluation could be performed on a spreadsheet. Nonetheless, the method produced numerical estimates of safety in a manner that was consistent, reproducible, and scrutable. The results enabled us to rank designs to identify areas where returns on research efforts would be the greatest. The numerical estimates were calibrated against what is achievable by current weapon safety systems. The use of expert judgement is inescapable, but these judgements are explicit and the method is easily implemented on an spreadsheet computer program.

7366 (UCRL-JC–112576) **A model for fuel fire duration and application to the B-1B bomber.** Magnoli, D.E. Lawrence Livermore National Lab., CA (United States). Oct 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940312–18: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001610. Source: OSTI; NTIS (US Sales Only); GPO Dep.

A model for determining the duration of a fuel-spill fire was developed. The scenario is that a parked fuel-and-weapon-laden system suffers damage that includes a hole in a fuel tank and that the spilling fuel ignites. Duration of the whole fire is not the focus of the model. What is of interest is duration at a nearby weapon storage point, which may be significantly remote from the spill location. The model derives duration as a function of several parameters, including the size of the fuel spill hole, the distance between the spill point and the point of interest, the amount of fuel available, and the form of the fuel tank that is spilling fuel. The effects of wind and of fire-fighting efforts are not considered in this study. Spilling from more than one fuel tank is not examined. The model is applied to the B-1B bomber. Model application to a specific system fixes some of the parameters. Fire duration at the weapons bays can thus be derived as a function of (1) the size of the hole from which the fuel is spilling and (2) the spill location on the aircraft. Parameter 1 determines how fast the fuel spills and thus how large the fire will be. Parameter 2 determines which tank the hole is in and therefore how much fuel is available, how much hydrostatic head there is, and how far the hole is from the weapons bay.

4501 Chemical Explosions and Explosives

Refer also to citation(s) 7004, 7326

7367 (LA-UR–93-2080) **Mach reflection of spherical detonation waves.** Hull, L.M. Los Alamos National Lab., NM (United States). [1993]. 9p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–4: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE93016604. Source: OSTI; NTIS; INIS; GPO Dep.

When two detonation waves collide, the shape of the wave front at their intersection can be used to categorize the flow as regular or irregular reflection. In the case of regular reflection, the intersection of the waves forms a cusp. In the case of irregular reflection, the cusp is replaced by a leading shock locus that bridges the incident waves. Many workers have studied irregular or Mach reflection of detonation waves, but most of the their experimental work has focused on the interaction of plane detonation waves.

Reflection of spherical detonation waves has received less attention. This study also differs from previous work in that the focus is to measure the relationship between the detonation velocity and the local wave curvatue for irregular reflection of spherical detonation waves. Two explosives with different detonation properties, PBX 9501 and PBX 9502, are compared.

7368 **Insensitive explosive.** Lee, Kien-yin; Storm, C.B. To Dept. of Energy. 1991. U.S. patent application 7-767,603. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003050. Source: OSTI; NTIS; GPO Dep.

This invention relates to the field of chemistry and, more particularly, to explosives. This invention is the result of a contract with the Department of Energy (Contract No. W-7405-ENG-36). It is desirable to use explosives in weapons and other applications which are less sensitive than the common explosives RDX, TNT, and HMX, since there have been catastrophic explosions of munitions which use these compounds. In preliminary characterization and sensitivity testing, it has been found that 3-amino-5-nitro-1,2,4-triazole (ANTA) is a promising insensitive high explosive. This report details the safety, production, and physical properties of ANTA.

7369 (SAND–92 2662C) **Examination of phase transformations and decomposition chemistry in thermally aged thin-film explosives.** Erickson, K.L.; Trott, W.M.; Renlund, A.M. Sandia National Labs., Albuquerque, NM (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. (CONF-9305189–6: 1993 joint Army, Navy, NASA, Air Force (JANNAF) Propulsion Systems Hazards Subcommittee meeting, Ft. Lewis, WA (United States), 10-14 May 1993). Order Number DE93040054. Source: OSTI; NTIS; GPO Dep.

To develop predictive models for the response of weapon systems to abnormal thermal environments, such as cookoff, an improved understanding of temperature-dependent thermophysical phenomena (such as phase transformations) and decomposition chemistry in totally confined explosive samples is needed. It is particularly important to examine the effects of maintaining-intimate contact between the decomposition products and the remaining condensed-phase explosive during slow reaction at elevated temperatures since confinement of the decomposition products may significantly affect thermophysical phenomena and decomposition reaction rates. The purpose of this work has been to examine experimentally the effects on condensed-phase chemistry which result when decomposition products remain in intimate contact with the reacting explosive during isothermal aging experiments at temperatures below those of the DTA exctherm for the explosive. To provide confinement, minimize vapor space, and permit condensed-phase chemical analysis, experiments were done using thin-film samples of the explosive, which were pressed and sealed between two infrared-transmitting windows, so that condensed-phase chemistry could be monitored using infrared spectroscopy. Experiments were done with NC, HMX, HMX-NC composite, and RDX samples. Results from the experiments with NC showed that for some decomposition mechanisms, the reaction rates for confined samples compared favorably with published reaction rates from unconfined samples. However, the results also demonstrated that for other mechanisms, the reaction rates were significantly affected by confinement of the decomposition products. The experiments with HMX and RDX indicated that some decomposition occurred at temperatures well below the temperatures of the respective DTA exotherms, and the experiments with HMX-NC composite samples showed some interaction between NC and HMX at temperatures as low as 150°C.

7370 (SAND–93-2568C) **Blasting, graphical interfaces and Unix.** Knudsen, S. (RE/SPEC, Inc., Albuquerque, NM (United States)); Preece, D.S. Sandia National Labs., Albuquerque, NM (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940144–2: 20. annual Society of Explosives Engineers meeting on explosives and blasting techniques, Austin, TX (United States), 30 Jan - 2 feb 1994). Order Number DE94003102. Source: OSTI; NTIS; GPO Dep.

A discrete element computer program, DMC (Distinct Motion Code) was developed to simulate blast-induced rock motion. To simplify the complex task of entering material and explosive design parameters as well as bench configuration, a full-featured graphical interface has been developed. DMC is currently executed on both Sun SPARCstation 2 and Sun SPARCstation 10 platforms and routinely used to model bench and crater blasting problems. This paper will document the design and development of the full-featured interface to DMC. The development of the interface will be tracked through the various stages, highlighting the adjustments made to allow the necessary parameters to be entered in terms and units that field blasters understand. The paper also discusses a novel way of entering non-integer numbers and the techniques necessary to display blasting parameters in an understandable visual manner. A video presentation will demonstrate the graphics interface and explains its use.

7371 (UCRL-ID–114715) **Fuel fire test results for RX-08-FK in a toroidal composite vessel.** Black, W. (Lawrence Livermore National Lab., CA (United States)); Bretl, D.; von Holtz, E.; Didlake, J.; Ferrario, M.; Spingarn, J.; Schwegel, J. Lawrence Livermore National Lab., CA (United States); Sandia National Labs., Livermore, CA (United States). Jul 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC04-76DP00789. Order Number DE94003863. Source: OSTI; NTIS; GPO Dep.

A fuel first test was conducted on October 15, 1992, during which a toroidal composite vessel containing 6.5 kg of RX-08-FK Paste Extrudable Explosive was subjected to a dynamic (transient) thermal environment. The vessel was mounted inside a closed, but vented, thin-walled steel cylinder, and the entire assembly was then engulfed in a fuel fire. Approximately 5 minutes into the test, the PEX began to burn. At the time reaction of PEX occurred, temperatures of the inside wall of the steel cylinder were 815C and temperatures on outside wall of the composite vessel ranged from 163–454C. Subsequently, temperatures in excess of 950C were reached inside the cylinder for tens of minutes. Based on criteria set forth in MIL-STD-1648A(AS), the RX-08-FK-loaded vessel passed the fuel fire test, because no violent reaction beyond burning was observed.

7372 (UCRL-JC–113295) **Unlike pair interactions in N_2-H_2O mixtures.** van Thiel, M.; Ree, F.H. Lawrence Livermore National Lab., CA (United States). Jul 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-930676–66: 14. international conference of the International Association for the Advancement of High Pressure Science and Technology, Colorado Springs, CO (United States), 27 Jun - 2 jul 1993). Order Number DE94004867. Source: OSTI; NTIS; INIS; GPO Dep.

Statisical-mechanical chemical equilibrium calculations have been performed to determined the deviation of the unlike species potential from that predicted by the Lorentz-Berthelot rule. The potentials of the water-water and nitrogen-nitrogen interactions have been reexamined in the light of remaining deviations from experiment. The resulting deviation of the constant from one (1), in the extended Lorentz-Berthelot rule, is determined from the best exp-6 potentials for nitrogen and water with consideration of possible deviations of the measured detonation velocity of RX-23-AB from its ideal equilibrium value.

4502 Nuclear Explosions and Explosives

Refer also to citation(s) 6284, 7153, 7437, 7438, 7450

7373 (DOE/FTR–94002828) **Travel to Russia and Germany for meetings on computer modeling of weapons and impact physics: Foreign trip report, September 4–21, 1993.** Boslough, M.B. Sandia National Labs., Albuquerque, NM (United States). 19 Oct 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE94002828. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Representatives from LLNL, LANL, SNL, Arzamas-16, and Chelyabinsk-70 attended the Second Computer Modeling Conference of Russian and US Weapons Laboratories at Arzamas-16,

Russia. The Russians are still building shock physics and radiation transport codes appropriate for weapons design. They are hampered by their weak computers. They are routinely using parallel computers. They have are large pool of code developers and analysts. Some of their algorithms are more advanced than those in the US. I visited experimental impact physics facilities Russia and Germany to discuss projects with collaborators.

7374 (PNL-SA–22307) **The use of benchmarking at the U.S. Department of Energy's Pantex Plant.** Anderson, F.G. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (United States)); Burling, J.; Moncivais, G.C.; Skelton, R.; Fulton, J.T.; Hostick, C.J.; Tuttle, T. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9309168–3: 2. international symposium on productive and quality improvement with a focus on government, Washington, DC (United States), 8-10 Sep 1993). Order Number DE94004365. Source: OSTI; NTIS; GPO Dep.

The U.S. Department of Energy's (DOE's) Pantex Plant, located in Amarillo, Texas, is responsible for the assembly, stockpile maintenance, and disassembly of nuclear weapons. Pantex is operated by the Mason and Hanger-Silas Mason Co., Inc. The following summarizes the pilot study that was designed to establish Pantex as a leader in using the continuous improvement tool of benchmarking within the DOE's Nuclear Weapon Complex (NWC). The pilot study was conducted with Mason and Hanger-Silas Mason Co. and Pacific Northwest Laboratory (PNL) personnel during 1992.

7375 (SAND–93-1235C) **Development of fast-running thermal and structural response models for probabilistic analysis of complex systems.** Benjamin, A.S.; Brown, N.N. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–27: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001826. Source: OSTI; NTIS; GPO Dep.

This paper describes two fast-running physical response algorithms, which were developed for the analysis of nuclear detonation pathways in nuclear weapons systems exposed to fires and crashes but which can be used for other applications such as probabilistic structural analyses of civil systems exposed to dynamic loadings and the dynamic analyses of nuclear reactors exposed to external events. The first is embodied in a computer code called Thermal Evaluation and Matching Program for Risk Applications (TEMPRA-3D). The second is contained in a computer code entitled Spring-mass Transient Response Evaluation for Structural Systems (STRESS-3D). TEMPRA-3D is a lumped-capacitance thermal analysis code that is extremely fast running and unconditionally stable. It contains fully integrated numerical models for many phenomena of interest in the evaluation of system responses, including thermal conduction, thermal radiation, thermal convection, chemical reactions, and material decomposition. The code is capable of calculating the timing of important events, such as component failures or the ignition of explosives. If uncertainty distributions are provided, it computes pairwise probabilities. STRESS-3D is a dynamical structural analysis code that models a system as a connection of masses and nonlinear springs. The principal functions of STRESS-3D are to calculate the dynamic responses to various types of impacts, focusing upon the stresses and strains in shell-like structures and the mean accelerations and displacements of solid components. Some of the key features of the code are: (1) explicit integration of Newton's law of motion for each mass; (2) spring forces evaluated form constitutive relationships and appropriate areas; (3) characterization of strain-hardening in inelastic materials and compressive load-bearing capability of foam materials; and (4) innovative modeling of shells.

7376 (SAND–93-1236C) **Development of smart searching algorithms for vulnerability and uncertainty analyses in probabilistic risk assessments.** Benjamin, A.S. Sandia National Labs., Albuquerque, NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000 ; AC04-76DP00789. (CONF-940312–33: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001825. Source: OSTI; NTIS; GPO Dep.

In order to evaluate the risk inherent in a complex system, including a reasonable accounting of the many uncertainties that characterize both the environments to which the system is exposed and the responses of the system to these environments, risk analysts are forced to use statistical approaches. If the system is very well designed for safety, then simple convolution or sampling approaches may have to be augmented by intelligent searching schemes. An excellent example is the prediction of the probability of an accidental nuclear detonation for a nuclear weapon system. Under practically all situations, accidental nuclear detonation is virtually impossible because modern nuclear weapon systems are designed to preclude it. They have a series of strong links and weak links that are guaranteed to fail in a prescribed order when exposed to virtually all credible abnormal environments, such as fires, impacts, punctures, crushes, external pressures, lightning or chemical attack. However, no engineered system is perfect, and under certain peculiar conditions involving combined environments that are spatially directs in the worst possible way, the strong links may fail before the weak links and an accidental nuclear detonation may conditions through an intelligent searching process and to determine whether their probability of occurrence is high enough to be of concern. In the weapon system application, LHS generates millions of sample members, each consisting of a different set of parameter values, and we must employ intelligent searching techniques to reduce this set to a more workable number. We do this through a discriminator subprocess, which we will describe.

7377 (SAND–93-2088) **Stockpile Dismantlement Database Training Materials.** Sandia National Labs., Albuquerque, NM (United States). Nov 1993. 356p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94003689. Source: OSTI; NTIS; GPO Dep.

This document, the Stockpile Dismantlement Database (SDDB) training materials is designed to familiarize the user with the SDDB windowing system and the data entry steps for Component Characterization for Disposition. The foundation of information required for every part is depicted by using numbered graphic and text steps. The individual entering data is lead step by step through generic and specific examples. These training materials are intended to be supplements to individual on-the-job training.

7378 (SAND–93-2173C) **Nuclear weapon system risk assessment.** Carlson, D.D. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–32: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001830. Source: OSTI; NTIS; GPO Dep.

Probabilistic risk assessment (PRA) is a process for evaluating hazardous operations by considering what can go wrong, the likelihood of these undesired events, and the resultant consequences. Techniques used in PRA originated in the 1960s. Although there were early exploratory applications to nuclear weapons and other technologies, the first major application of these techniques was in the Reactor Safety Study, WASH-1400, [1] in which the risks of nuclear power accidents were thoroughly investigated for the first time. Recently, these techniques have begun to be adapted to nuclear weapon system applications. This report discusses this application to nuclear weapon systems.

7379 (UCRL-ID–115283) **Analysis of spark-induced bubble experiments using CALE.** Simonson, S.C. III; McAllister, S.W. Lawrence Livermore National Lab., CA (United States). Oct 1993. 69p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94003667. Source: OSTI; NTIS; GPO Dep.

Calculations were made using the 2-D hydrodynamics code CALE of underwater bubble oscillations and collapse for two situations of interest in the development of underwater acoustic sources. The first is the case of a single bubble to which energy is added to prolong oscillations. The second is the case of a three-bubble array, which typifies one end element in a linear array.

Comparisons were made with a series of experiments with spark-induced bubbles carried out at Tetra Corp. The bubbles were made at a depth of 64 cm with periods of about 400 μs. Onedimensional calculations were used to study single bubbles. The 1-D results showed that energy needs to be added at a precise phase in order to promote bubble re-excitation. The experiments showed evidence of losses caused by interaction with the relatively large electrodes upon collapse, leading to a 50 percent reduction in amplitude and period of the second oscillation. When a second discharge was made at the end of the first o on, the next osculation had 80 percent of the amplitude of the first. This can be interpreted either as formation of a new bubble, or as pumping the previous bubble, both occurring in a disturbed environment. Two-dimensional calculations were used to study the three-bubble array. The 2-D results showed significant interaction between the central and side bubbles, leading to jetting. For the particular combination of size and spacing used, jetting occurred in the third oscillation of the bubbles.

7380 (UCRL-ID–115681) **Computer simulations of WIGWAM underwater experiment.** Kamegai, Minao; White, J.W. Lawrence Livermore National Lab., CA (United States). Nov 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004226. Source: OSTI; NTIS; GPO Dep.

We performed computer simulations of the WIGWAM underwater experiment with a 2-D hydro-code, CALE. First, we calculated the bubble pulse and the signal strength at the closest gauge in one-dimensional geometry. The calculation shows excellent agreement with the measured data. Next, we made two-dimensional simulations of WIGWAM applying the gravity over-pressure, and calculated the signals at three selected gauge locations where measurements were recorded. The computed peak pressures at those gauge locations come well within the 15% experimental error bars. The signal at the farthest gauge is of the order of 200 bars. This is significant, because at this pressure the CALE output can be linked to a hydro-acoustics computer program, NPE Code (Nonlinear Progressive Wave-equation Code), to analyze the long distance propagation of acoustical signals from the underwater explosions on a global scale.

7381 (UCRL-JC–114200) **WESVA: A decision aid for comparing warhead advanced surety R&D options.** Homsy, R.V.; Sicherman, A.; Stephens, D.R. Lawrence Livermore National Lab., CA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940312–24: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001764. Source: OSTI; NTIS; INIS; GPO Dep.

Newly designed warheads that incorporate advanced surety concepts can reduce the risks of accidental radiological material dispersal, nuclear detonation, and unauthorized use. But these potential surety benefits entail cost and performance penalties. Present constraints on R&D budgets, time, and allowable nuclear tests also create significant uncertainties as to whether new concepts can be successfully developed and implemented. These factors complicate the decisions involved in selecting surety concepts for more extensive R&D. To help decision makers compare R&D options, we developed a decision aid called Weapon Safety Value Assessment (WESVA). This paper describes WESVA and suggests how a WESVA-like approach can be of interest in other decision-making contexts.

7382 (UCRL-JC–115269) **Probabilistic cost-benefit analysis of enhanced safety features for strategic nuclear weapons at a representative location.** Stephens, D.R.; Hall, C.H.; Holman, G.S.; Graham, K.F.; Harvey, T.F.; Serduke, F.J.D. Lawrence Livermore National Lab., CA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940312–21: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001765. Source: OSTI; NTIS; GPO Dep.

We carried out a demonstration analysis of the value of developing and implementing enhanced safety features for nuclear weapons in the US stockpile. We modified an approach that the Nuclear Regulatory Commission (NRC) developed in response to a congressional directive that NRC assess the "value-impact" of regulatory actions for commercial nuclear power plants. Because improving weapon safety shares some basic objectives with NRC regulations, i.e., protecting public health and safety from the effects of accidents involving radioactive materials, we believe the NRC approach to be appropriate for evaluating weapons-safety cost-benefit issues. Impact analysis includes not only direct costs associated with retrofitting the weapon system, but also the expected costs (or economic risks) that are avoided by the action, i.e., the benefits.

7383 (UCRL-JC–115404) **The integration of human factors into the risk assessment of a nuclear device arming and firing system.** Altenbach, T.; Ferrell, W. Lawrence Livermore National Lab., CA (United States). 10 Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940312–17: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001606. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This study is concerned with the potential for the release of plutonium from a nuclear device due to hardware component failures, human errors, and/or external natural phenomena affecting the A&F system. Intentional human actions such as sabotage or terrorist subversion were excluded from this analysis. The time period of concern begins when the device and the A&F equipment are located physically adjacent at ground zero, until the device is fully stemmed. This time period is divided into the following phases: device delivery and installation, hot dry run testing, and device insertion. Dispersal following a detonation of the device high explosive is the only release mode considered, and no attempt was made to estimate the consequences of a dispersal.

4505 Strategic Defense Initiative

7384 (LA-SUB–93-263) **Object Tracking and Designation (OTD): Final report, Phase 2.** Los Alamos National Lab., NM (United States); Strategic Defense Initiative Organization, Washington, DC (United States). Nov 1990. 16p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94002566. Source: OSTI; NTIS; GPO Dep.

We demonstrated on the Object Tracking and Designation (OTD) project, the effectiveness of the 001 technology to the development of complex scientifically-oriented applications for SDI. This document summarizes the results of the project. In the OTD system, Object sightings from Measurement Processing are sorted by Object Sorting into azimuth/elevation bins, then passed to Object Screening. Object Screening separates sightings which are part of an established track from those for which no track has been established. In Process Sighting, sightings determined to be part of established tracks are sent to Update Tracks; uncorrelated sightings are sent to Generate Tracks. Generate Tracks first performs a rate smoothing of the data in Rate Smoothing. In Candidate Track Selection (CTS) uncorrelated sightings are compared with the previous five to seven frames. Those sightings which can be put together to form a candidate ballistic trajectory are sent to the Trajectory Fitting process. In the Trajectory Fitting process, candidate tracks are fitted to precision trajectories. Valid trajectories are sent to Radiometric Discriminant Initialization in the form of a new track message, and object sightings making up the trajectory are removed from the Object Sighting data structure. In Radiometric Discriminant Initialization, radiometric discriminants are produced from the new track message and the resulting discriminant values used to initialize a track record in the Object Track File data structure which is passed to the Prediction function. The Metric Discrimination process uses angle data to determine object lethality. The object's designation is then sent to the Prediction process. In the Prediction process the track's position and uncertainty on the next frame is predicted based upon a coefficient corresponding to the object's estimated class and on the expected interception of the track and the scanner on the next frame.

4506 Chemical and Biological

Refer also to citation(s) 6925

54 ENVIRONMENTAL SCIENCES

Refer also to citation(s) 6699, 6794

7385 (DOE/FTR–93017644) **Travel to Japan for meetings on global environmental challenges and industrial pollution control: Foreign trip report, November 1–16, 1991.** Tischer, R.E. USDOE Pittsburgh Energy Technology Center, PA (United States). 18 Dec 1991. 16p. Sponsored by USDOE, Washington, DC (United States). Order Number DE93017644. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Richard E. Tischer, Project Manager, US Department of Energy, Pittsburgh Energy Technology Center (DOE/PETC;FTS 723-4891) visited Japan on November 1–16, 1991. The purpose of this trip was threefold: (1) to participate in an International Energy Agency (IEA) International Conference on Technology Responses to Global Environmental Challenges held in Kyoto; (2) to participate in the Third DOE-PETC/Agency of Natural Resources and Energy (ANRE)-Electric Power Development Company (EPDC) Technical meeting and the Fourth DOE-PETC/Ministry of International Trade and Industry (MITI)-ANRE Subcommittee meeting on Pollution Control Technology held in Tokyo; and (3) to visit three sites carrying out ANRE-sponsored R&D, which were located in the Nagasaki Prefecture. Representatives from four US industrial and research organizations participated, at their own expense, in the Tokyo meeting and site tours.

7386 (UCRL-ID–114900) **Introduction to the nuclear criticality safety evaluation of facility X-705, Portsmouth Gaseous Diffusion Plant.** Sheaffer, M.K.; Keeton, S.C. Lawrence Livermore National Lab., CA (United States). 16 Aug 1993. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004806. Source: OSTI; NTIS; INIS; GPO Dep.

This report is the first in a series of documents that will evaluate nuclear criticality safety in the Decontamination and Recovery Facility, X-705, Portsmouth Gaseous Diffusion Plant. It provides an overview of the facility, categorizes its functions for future analysis, reviews existing NCS documentation, and explains the follow-on effort planned for X-705. A detailed breakdown of systems, subsystems, and operational areas is presented and cross-referenced to existing NCS documentation.

5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 6061, 6065, 6070, 6240, 6243, 6245, 6290, 6293, 6360, 6581, 6585, 6589, 6590, 6592, 6725, 6784, 6790, 6792, 6842, 6866, 6956, 7315, 7360, 7432, 7437, 7438, 7458, 7467, 7499, 7506, 7513

7387 (BNL–49231) **Ozone production at a rural site in Georgia during the summer 1992 SOS campaign.** Kleinman, L.I. (and others); Lee, Yin-Nan; Springston, S.R. Brookhaven National Lab., Upton, NY (United States). Jun 1993. 7p. Sponsored by USDOE, Washington, DC (United States);Environmental Protection Agency, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-940115–13: 74. American Meteorological Society annual meeting, Nashville, TN (United States), 23-28 Jan 1994). Order Number DE94003989. Source: OSTI; NTIS; GPO Dep.

As part of the Southern Oxidant Study (SOS) (UCAR, 1990), Brookhaven National Laboratory operated a "SENIOR" (South Eastern Network for Intensive Ozone Research) measurement site on a campaign basis during parts of the summers of 1991 and 1992. Measurements were made for the purpose of understanding the pervasive high levels of O_3 observed in the southeastern US (Meagher et al, 1987 Aneja et al, 1990; NRC, 1991). In this article the authors focus on the 1992 observations of O_3 and the predication of O_3 formation rates based on a radical budget calculation and based on the photostationary state.

7388 (BNL–49690) **The validation of ATSR measurements with in situ sea temperatures.** Minnett, P.J. (Brookhaven National Lab., Upton, NY (United States)); Stansfield, K.L. Brookhaven National Lab., Upton, NY (United States). 8 Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States);National Oceanic and Atmospheric Administration, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9310231–1: 2. ERS symposium on space at the service of our environment, Hamburg (Germany), 11-14 Oct 1993). Order Number DE94003195. Source: OSTI; NTIS; GPO Dep.

The largest source of uncertainty in the retrieval of SST (sea-surface) temperature from space-borne infrared radiometric measurements is in the correction for the effects of the intervening atmosphere. During a research cruise of the R/V Alliance measurements of sea surface temperature, surface meteorological variables and surface infrared radiances were taken. SST fields were generated from the ATSR data using pre-launch algorithims derived by the ATSR Instrument Team (A.M. Zavody, personal communication), and the initial comparison between ATSR measurements and SST taken along the ship's track indicate that the dual-angle atmospheric correction is accurate in mid-latitude conditions.

7389 (CONF-9306266–) **White House Conference on Global Climate Change.** USDOE, Washington, DC (United States). [1993]. 102p. Sponsored by USDOE, Washington, DC (United States). From Global climate change; Washington, DC (United States); 10-11 Jun 1993. Source: OSTI (Free of Charge).

President Clinton has directed the White House office on Environmental Policy to coordinate an interagency process to develop a plan to fulfill the commitment he made in his Earth Day address on April 21, 1993. This plan will become the cornerstone of the Climate Change Plan that will be completed shortly after the Rio Accord enters into force. The Office on Environmental Policy established the Interagency Climate Change Mitigation Group to draw on the expertise of federal agencies including the National Economic Council; the Council of Economic Advisors; the Office of Science and Technology Policy; the Office of Management and Budget; the National Security Council; the Domestic Policy Council; the Environmental Protection Agency; and the Departments of Energy, Transportation, Agriculture, Interior, Treasury, Commerce, and State. Working groups have been established to examine six key policy areas: energy demand, energy supply, joint implementation, methane and other gases, sinks, and transportation. The purpose of the White House Conference on Global Climate Change was to "tap the real-world experiences" of diverse participants and seek ideas and information for meeting the President's goals. During the opening session, senior administration officials defined the challenge ahead and encouraged open and frank conversation about the best possible ways to meet it.

7390 (DOE/CE/23810–22E) **ARTI Refrigerant Database: [Quarterly progress report, 1 July 1993–30 September 1993].** Calm, J.M. Calm (James M.), Great Falls, VA (United States). 28 Nov 1993. 159p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91CE23810. Order Number DE94004906. Source: OSTI; NTIS; GPO Dep.

The Refrigerant Database consolidates and facilitates access to information to assist industry in developing equipment using alternative refrigerants. The underlying purpose is to accelerate phase out of chemical compounds of environmental concern. The database provides bibliographic citations and abstracts for publications that may be useful in research and design of air-conditioning and refrigeration equipment. The complete documents are not included, though some may be added at a later date. The database identifies sources of specific information on R-32, R-123, R-124, R-125, R-134, R134a, R-141b, R-142b, R-143a, R-152a, R-227ea, R-245ca, R-290 (propane), R-717 (ammonia), ethers, and others as well as azeotropic and zeotropic blends of these fluids. It addresses lubricants including alkylbenzene, polyalkylene glycol, polyol ester, and other synthetics as well as mineral oils. It also references documents addressing compatibility of refrigerants and lubricants with metals, plastics, elastomers, motor insulation, and other materials used in refrigerant circuits. Incomplete citations or abstracts are provided for some documents. They are included to

accelerate availability of the information and will be completed or replaced in future updates.

7391 (DOE/ER–0597T) **Global Change Research: Summaries of research in FY 1993.** USDOE Office of Energy Research, Washington, DC (United States). Oct 1993. 230p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003150. Source: OSTI; NTIS; GPO Dep.

This document describes the activities and products of the Global Research Program in FY 1993. This publication describes all of the projects funded by the Environmental Sciences Division of DOE under annual contracts, grants, and interagency agreements in FY 1993. Each description contains the project's title; its 3-year funding history (in thousands of dollars); the period over which the funding applies; the name(s) of the principal investigator(s); the institution(s) conducting the projects; and the project's objectives, products, approach, and results to date (for most projects older than 1 year). Project descriptions are categorized within the report according to program areas: climate modeling, quantitative links, global carbon cycle, vegetation research, ocean research, economics of global climate change, education, information and integration, and NIGEC. Within these categories, the descriptions are grouped alphabetically by principal investigator. Each program area is preceded by a brief text that defines the program area, states its goals and objectives, lists principal research questions, and identifies program managers.

7392 (DOE/ER/61010–T9) **Formation and emission of methane in rice soils: Experimental determination and modeling analysis: Final report.** Law, V.J.; Bhattacharya, S.K. California Univ., Davis, CA (United States). 31 Aug 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC03-90ER61010. Order Number DE93040720. Source: OSTI; NTIS; GPO Dep.

Rice paddy soils have been identified as a major source of methane emissions contributing to the observed atmospheric increase in methane. This points to the need for a method of quantifying and predicting methane emissions for the widely varying conditions used in rice agriculture throughout the world. In the present work, a mathematical model for estimating the emission of methane from rice paddy soils is developed and refined. Kinetic parameters for methanogenesis in a Louisiana rice soil are determined from laboratory data on methane production from acetic acid substrate. Use of a stirred reactor allows simultaneous measurement of acetate consumption and methane production while minimizing mass transfer limitations. An existing model for rice plant growth is utilized to provide data on the availability of root exudates as a carbon source for the methanogens. The final methane model includes the kinetic parameters, plant data, and estimated transport parameters. With adjustments in these parameters, it provides an acceptable match to field data.

7393 (DOE/ER/61010–T10) **Methane emissions from natural wetlands.** Meyer, J.L. (Georgia Univ., Athens, GA (United States)); Burke, R.A. Jr. California Univ., Davis, CA (United States). [1993]. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC03-90ER61010. Order Number DE93040796. Source: OSTI; NTIS; GPO Dep.

Analyses of air trapped in polar ice cores in conjunction with recent atmospheric measurements, indicate that the atmospheric methane concentration increased by about 250% during the past two or three hundred years (Rasmussen and Khalil, 1984). Because methane is a potent "greenhouse" gas, the increasing concentrations are expected to contribute to global warning (Dickinson and Cicerone, 1986). The timing of the methane increase suggests that it is related to the rapid growth of the human population and associated industrialization and agricultural development. The specific causes of the atmospheric methane concentration increase are not well known, but may relate to either increases in methane sources, decreases in the strengths of the sinks, or both.

7394 (DOE/ER/61059–2) **Cloud and aerosol characterization for the ARM central facility: Multiple remote sensor techniques development: Final technical report.** Sassen, K. Utah Univ., Salt Lake City, UT (United States). Dept. of Meteorology. 1 Nov 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER61059. Order Number DE94003523. Source: OSTI; NTIS; GPO Dep.

In support of the initial phase of the Instrument Development Program (IDP) of the Atmospheric Radiation Measurement (ARM) program, the authors have researched the means by which multiple remote sensing techniques could be best applied to characterizing the cloudy atmosphere. This research has directly supported the short-term goal of aiding in the selection of the most appropriate instrumentation for ARM Clouds and Radiation Testbed (CART) sites, but also has more long-term consequences for the application of remote sensing for measuring cloud properties of crucial concern to general circulation and climate models. To accomplish the goals they have (1) developed a mobile, state-of-the-art, scanning polarization diversity lidar (PDL) to test a variety of techniques for cloud remote sensing, including simultaneous dual-wavelength and dual-polarization, and high-speed variable field-of-view operations; (2) successfully participated in field projects using the PDL along with other remote sensors and instrumented aircraft to obtain detailed datasets for the testing of instrument techniques; (3) in collaboration with researchers at the NOAA Wave Propagation Laboratory, used numerical cloud modeling and empirical studies to develop and refine remote sensing approaches for cloud property retrieval.

7395 (DOE/ER/61065–3) **Testbed model and data assimilation for ARM: Progress report No. 3, 1 September 1992–30 April 1993.** Louis, J.F. Atmospheric and Environmental Research, Inc., Cambridge, MA (United States). 28 Apr 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER61065. Order Number DE94000432. Source: OSTI; NTIS; GPO Dep.

The ultimate objectives of this research are to further develop ALFA (AER Local Forecast and Assimilation) model originally designed at AER for local weather prediction and apply it to several related purposes in connection with the Atmospheric Radiation Measurement (ARM) program: (a) to provide a testbed that simulates a global climate model in order to facilitate the development and testing of new cloud parametrizations and radiation models; (b) to assimilate the ARM data continuously at the scale of a climate model, using the adjoint method, thus providing the initial conditions and verification data for testing parametrizations; (c) to study the sensitivity of a radiation scheme to cloud parameters, again using the adjoint method, thus demonstrating the usefulness of the testbed model. The data assimilation uses a variational technique that minimizes the difference between the model results and the observation during the analysis period. The adjoint model is used to compute the gradient of a measure of the model errors with respect to nudging terms that are added to the equations to force the model output closer to the data.

7396 (DOE/ER/61365–T2) **An evaluation of the utility of ground-based high resolution interferometer (GB-HIS) soundings of the planetary boundary layer.** Ding, Hanjun. Wisconsin Univ., Madison, WI (United States). 1993. 84p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract FG02-92ER61365. Grant NAG-1-1177. Order Number DE94000960. Source: OSTI; NTIS; GPO Dep.

This thesis evaluates atmospheric soundings generated from the ground-based high resolution interferometer soundes (GB-HIS). The two goals are (1) to estimate the accuracy of GB-HIS temperature and dew point soundings using statistical analysis and comparison against observation from simultaneous radiosondes, and (2) to exploit the high temporal resolution of GB-HIS data set to analyze planetary boundary layer (PBL) thermodynamic properties. This thesis consists of five additional sections. Section 2 describes the methodology of GB-HIS retrieval as developed by Smith (1993). Section 3 provides a statistical error analysis of the GB-HIS system. Section 4 shows the utility of GB-HIS data in monitoring the PBL evolution, while Section 5 discusses and validates a simple mixed-layer growth model recently developed by Stull (1993). Finally, Section 6 offers conclusions and suggestions for further studies.

7397 (DOE/EV/03688–T3) **Consequence assessment for Airborne Releases of SO_2 from the Y-12 Pilot Dechlorination Facility.** Pendergrass, W.R. National Oceanic and Atmospheric

Administration, Oak Ridge, TN (United States). Air Resources Lab. Atmospheric Turbulence and Diffusion Div. Jun 1992. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI05-76EV03688. Order Number DE93017968. Source: OSTI; NTIS; INIS; GPO Dep.

The Atmospheric Turbulence and Diffusion Division was requested by the Department of Energy's Oak Ridge Operations Office to conduct a consequence assessment for potential atmospheric releases of SO_2 from the Y-12 Pilot Dechlorination Facility. The focus of the assessment was to identify "worst" case meteorology which posed the highest concentration exposure potential for both on-site as well as off-site populations. A series of plausible SO_2 release scenarios were provided by Y-12 for the consequence assessment. Each scenario was evaluated for predictions of downwind concentration, estimates of a five-minute time weighted average, and estimate of the dimension of the puff. The highest hazard potential was associated with Scenario 1, in which a total of eight SO_2 cylinders are released internally to the Pilot Facility and exhausted through the emergency venting system. A companion effort was also conducted to evaluate the potential for impact of releases of SO_2 from the Pilot Facility on the population of Oak Ridge. While specific transport trajectory data is not available for the Pilot Facility, extrapolations based on the Oak Ridge Site Survey and climatological records from the Y-12 meteorological program does not indicate the potential for impact on the city of Oak Ridge. Steering by the local topographical features severely limits the potential impact ares. Due to the lack of specific observational data, both tracer and meteorological, only inferences can be made concerning impact zones. It is recommended tat the Department of Energy Oak Ridge Operations examine the potential for off-site impact and develop the background data to prepare impact zones for releases of hazardous materials from the Y-12 facility.

7398 (DOE/FTR–93017643) **Travel to the Netherlands for the International Workshop on CO_2 and the Biosphere: Foreign trip report, November 13–22, 1991.** Dahlman, R.C. USDOE, Washington, DC (United States). [1991]. 9p. Sponsored by USDOE, Washington, DC (United States). Order Number DE93017643. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The purpose of this travel was to present a paper at the International Workshop on CO_2 and the Biosphere. The paper described DOE-supported research on CO_2 and plants, and the traveler participated in discussions of scientific findings and ideas for future research needs related to the direct effect of CO_2 on plants, crops and ecosystems. In addition, the traveler met with Prof Mark Stitt (Univ Heidelberg) to discuss approaches and opportunities for using molecular techniques in fundamental studies of plant response to CO_2 enrichment.

7399 (DOE/HWP–147) **Energy recovery ventilation as a radon mitigation method for Navy family housing in Guam.** USDOE Oak Ridge Operations Office, TN (United States); Oak Ridge National Lab., TN (United States). HAZWRAP Support Contractor Office. Dec 1993. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94005146. Source: OSTI; NTIS; INIS; GPO Dep.

Energy recovery ventilation involves the exchange of contaminated indoor air with fresh, uncontaminated outdoor air with recovery of energy. During radon mitigation diagnostics, air change measurements were performed within three typical Navy family houses, and some were found to be well below recommended minimum standards. The only practical way to solve the indoor air quality problem was to increase the ventilation rate. Options were evaluated, and it was decided to install energy recovery ventilation (ERV) systems. An ERV system is a packaged unit complete with blower fans, controls, and air-to-air heat exchanger. However, because of economical limits on the quantity of conditioned air that can be exchanged, ERV has a finite range of application in radon abatement. In Guam, ERV has potential applications in up to 370 units and in an additional 154 units if the mechanical systems are moved indoors. The performance of ERV systems were evaluated during a demonstration program to determine the removal efficiency of radon.

7400 (DOE/OR/00033–T554) **Interactions between a tropical mixed boundary layer and cumulus convection in a radiative-convective model.** Dean, C.L. (Pennsylvania State Univ., University Park, PA (United States)). Oak Ridge Inst. for Science and Education, TN (United States); Pennsylvania State Univ., University Park, PA (United States). May 1993. 142p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE94000848. Source: OSTI; NTIS; GPO Dep.

This report details a radiative-convective model, combining previously developed cumulus, stable cloud and radiation parameterizations with a boundary layer scheme, which was developed in the current study. The cloud model was modified to incorporate the effects of both small and large clouds. The boundary layer model was adapted from a mixed layer model was only slightly modified to couple it with the more sophisticated cloud model. The model was tested for a variety of imposed divergence profiles, which simulate the regions of the tropical ocean from approximately the intertropical Convergence Zone (ITCZ) to the subtropical high region. The sounding used to initialize the model for most of the runs is from the trade wind region of ATEX. For each experiment, the model was run with a timestep of 300 seconds for a period of 7 days.

7401 (DOE/RL/12092–T1) **Partial and preliminary inventory of NOAA data for ARM/IDASS research.** Martner, B.E. (comp.). National Oceanic and Atmospheric Administration, Boulder, CO (United States). Wave Propagation Lab. Jun 1991. 32p. Sponsored by USDOE, Washington, DC (United States);National Oceanic and Atmospheric Administration, Washington, DC (United States). DOE Contract AI06-91RL12092. Order Number DE94000567. Source: OSTI; NTIS; GPO Dep.

The first quarter of 1991 was an extremely active time for atmospheric measurements in the Denver area. Four field projects were conducted with overlapping schedules and area domains between mid-January and mid-April. The data collected may be of mutual interest to the participants of the various projects. Data inventory catalogs for each project will assist researchers by documenting the kinds of measurements, periods of observation, the data archival mediums, and the data availability. This report provides a partial and preliminary inventory of data obtained for the Department of Energy's Atmospheric Radiation Measurement (ARM) program Integrated Data Assimilation and Sounding System (IDASS) research. It includes only those measurements obtained by the National Oceanic and Atmospheric Administration's Wave Propagation Laboratory and Aeronomy Laboratory (NOAA/WPL and NOAA/AL). Many of these data are currently undergoing post-processing and inspection by each instrument's operating group to improve and insure data quality. Therefore, the information in this report is preliminary.

7402 (ECN-RX–93-107) **Reduction of solar radiation by manmade aerosol.** Ten Brink, H.M. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Oct 1993. 12p. Order Number DE94729808. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

Article intended for the proceedings of the European Conference on Climate Change, Copenhagen, Denmark, 6-10 Sep 1993.

The amount of solar radiation reaching the earth is reduced by reflection of the light on (manmade) aerosol particles. This effect presents the major uncertainty in quantifying climate change by the increase in greenhouse gas emissions. The dominant reason for the uncertainty is the localized character of aerosol. It is the aim of the present study to quantify the effect of anthropogenic aerosol on the local climate in Europe. This is realized along three interconnected approaches. First, empirical factors stemming from measurements in the US and used in the present estimates of the reflection of solar radiation by anthropogenic aerosol are checked for their validity in the European domain. Secondly, historical data on solar flux in Europe are related to the historic trend in aerosol loading. Finally, a sophisticated aerosol and cloud (radiation) module is developed for incorporation in a climate model. The radiation module uses aerosol characteristics as measured in the field and is validated via solar radiation measurements. Since the study recently started only preliminary results are reported. 1 fig., 13 refs.

7403 (ENEA-RT-AMB–91-18) **Atmospheric radiative transfer: LOWTRAN 7 calculation code.** Cagnetti, V. (ENEA,

Casaccia (Italy). Area Energia Ambiente e Salute); Corticelli, M.A.; Santucci, R. No corporate text available. Jan 1993. 56p. (In Italian). (RT/AMB–91-18). Order Number DE94727313. Source: OSTI; NTIS (US Sales Only).

The main problem of correcting telemetered data from the effect due to the absorption and consequent riemission of energy, in the observed wavelength, by the atmosphere, can be solved with different strategies. The Lowtran code, developed by NOOA is based on a mathematical model for the simulation of the iteration between photons and atmosphere; this code has been adapted to the 3. 20 version of FORTRAN Microsoft for PC IBM/DOS compatible. The code is fully explained and commented.

7404 (ENEA-RT-AMB–92-11) **Wind field modelling: Mass consistent model and simulation of atmospheric dispersion of passive pollutants over complex terrain and heterogeneous surfaces.** Busuoli, M. (ENEA, Bologna (Italy)); Zanini, G. No corporate text available. Apr 1993. 103p. (In Italian). (RT/AMB–92-11). Order Number DE94727312. Source: OSTI; NTIS (US Sales Only).

Numerical modeling techniques are applied to study the atmospheric dispersion of passive pollutant over complex terrain. A code uses the winds provided by a diagnostic wind model utilizing terrain following coordinates, to advect and diffuse the effluent. The numerical simulations refer to the tracer release (SF_6) experiments carried out in the lake Brasimone area (Appennine mountains between Bologna and Florence) during June 1985.

7405 (ETDE-IT–93-249) **Urban area PBL study by means of Doppler sodar and cryogenic radiometer: Present status of research.** Abbate, G. (Rome Univ. (Italy). Dipt. di Fisica); Calisse, P.; Fiocco, G.; Rao, M.P.; Berteotti, C. No corporate text available. 1992. 11p. (CONF-9206419–1: Geophysics and environment: Basic pollution, Rome (Italy), 16-18 Jun 1992). Order Number DE94727351. Source: OSTI; NTIS (US Sales Only).

With the aim of contributing to a deeper knowledge of the interrelation between radiative and dynamic energy exchanges in the planetary boundary layer (PBL) of an urban environment, two measurement campaigns were carried out in Rome, 12-18 Sept. 1990 and 16-22 Sept. 1991, using a tri-axial Doppler sodar operating in the monostatic mode and a cryogenic radiometer operating at about 850 micro m wavelength. The two instruments were operated simultaneously, the sodar for wind field characterization and the cryogenic radiometer for measurements of the associated radiation field and atmospheric temperature fluctuations. Depending upon the meteorological conditions, the two sets of data were found to exhibit fairly high values of correlation. Cross-correlograms are presented here between vertical velocity (averaged along 300 m in height) and radiometric data, for typical PBL conditions, together with scatterplots clearly showing the relation between the two data sets. Kinematic eddy sensible heat fluxes computed by using radiometric temperature rather than ground temperature values were found to be lower, as expected.

7406 (EUR–14411, pp. 69-150) **Properties and behaviour of radon and thoron and their decay products in the air.** Porstendoerfer, J. (Goettingen Univ. (Germany). Isotopenlaboratorium fuer Biologische und Medizinische Forschung). Commission of the European Communities, Luxembourg (Luxembourg). 1993. In *Fifth International Symposium on the natural radiation environment.* 282p. Order Number DE94608870. Source: OSTI; NTIS (US Sales Only); INIS.

In a first chapter, this paper describes radon and thoron decay chains and their decay products. In a second chapter, the main radioactive decay properties, the quantities and the units are listed, which are used in radiation protection in relation with the radon / thoron daughters in air and in the inhalation exposure of individuals. The main processes influencing the concentration and activity aerosol size distribution of the radon and thoron daughters are summarized in chapter 3. In the fourth chapter, radon, thoron, and their decay products in the human environment are characterized. Data of activity concentration and activity aerosol size distribution measurements obtained under realistic conditions in different dwellings and in the open atmosphere are reported. In chapter 5, the implications of the experimental data for dose factors and estimates the average dose of the population by radon, thoron, and their decay products. 149 refs., 17 tabs., 22 figs.

7407 (IKE–2-99) **Modeling of the deposition processes during dew formation in complex structures: Contribution to EUROTRAC subproject BIATEX. Final report.** Bieder, U.; Schatz, A. Stuttgart Univ. (Germany). Inst. fuer Kernenergetik und Energiesysteme. Jan 1993. 130p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 07EU752. Order Number DE94734010. Source: OSTI; NTIS (US Sales Only).

Measurements and simple theoretical estimates have shown, that wet vegetation can be a more effective sink for air pollutants than dry vegetation. This is valid especially for water soluble compounds and for compounds which are very reactive in the liquid phase. Nevertheless, a quantification of the enhanced air pollutant deposition to wet vegetation has not been carried out. In this study, the enhanced trace gas deposition to wet vegetation is investigated on the example of low and homogeneous vegetation wetted by dew. Therefore a one dimensional Three-Layer-Resistance-Model was developed and tested against measurements. The simulation calculation shows a strong dependency of the SO_2 deposition on the availability of neutralizing compounds near the ground, especially of NH_3. Highly water soluble gases, as H_2O_2, dissolve almost totally in dew, so their deposition rate to wet vegetation can be up to 80% higher than to dry vegetation. The deposition rate of moderate soluble gases, which are reactive in the liquid phase, such as SO_2, can enhance in the presence of dew up to 50%. Even for insoluble gases, which are reactive in the liquid phase, as O_3, the deposition rate to wet vegetation can enhance up to 20% compared to the deposition to dry vegetation. (orig.). 83 refs., 23 tabs., 42 figs.

7408 (IVL-B–1106) **Ammonia emissions from two fertilized wheat fields.** Ferm, M. Swedish Environmental Research Inst., Goeteborg (Sweden). Jul 1993. 12p. Order Number DE94730415. Source: OSTI; NTIS.

The NH_3 emissions from two winter wheat fields have been measured with a new variant of the gradient technique. Wind speed weighted, weekly average NH_3 concentrations and the average wind speed were determined using passive samplers. One of the fields received an optimum amount of nitrogen fertilization and the second field 60% of the optimum. The measurements started on June 11th and ended on the day of harvesting (Aug 3rd, 1992). The measurements clearly show that the NH_3 emissions equal the NH_3 deposition from the atmosphere, and that the two fluxes are very small and negligible compared to the nitrogen content of the crop. An explanation to this may be that the summer was unusually warm and dry. No loss of nitrogen could be detected from the weekly crop analyses. 6 refs, 8 figs, 2 tabs

7409 (LA-UR–93-4000) **Development of methods for evaluating options for improving air quality in Santiago, Chile and its environs: Final report.** Williams, M.D.; Brown, M.J. Los Alamos National Lab., NM (United States). Oct 1993. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003955. Source: OSTI; NTIS; GPO Dep.

Santiago, Chile has a serious air pollution problem. Aerosols reach very high levels and ozone exceeds US ambient standards on over 100 days a year. Chileans are very concerned about the poor air quality of Santiago and the effect of emissions from their copper smelters both near Santiago and at other sites. Officials from both the Santiago metropolitan air quality commission (La Comision Especial de Descontaminacion de le Region Metropolitana) and a government owned copper development company (La Empress Nacional de Mineria (ENAMI)) have asked for assistance to deal with the air quality problems in the city and associated with smelter emissions. This report describes the first steps in that effort. Santiago lies in a valley between a small coastal range to the west and the towering Andes to the cast. Air motion is greatly affected by the major topographical features which include the Pacific Ocean, the coastal range, and the Andes. In this first year of work the authors concentrated on gathering information on the meteorology, topography, and air quality of the metropolitan region. They examined two smelter sites and applied models to them to help their understanding and to provide assistance to ENAMI. One smelter, Ventanas, was located on the Pacific coast to the northwest of Santiago, while the other, Paipote, was located several

hundred kilometers to the north. The Ventanas emissions may potentially affect Santiago air quality. Several advantages of working with the smelters in the first phase of the project are: (1) there is more monitoring in the vicinity of the smelters, (2) the development of a useful emission inventory is easier, (3) they pose a simpler problem of immediate interest whose resolution will provide an early benefit to the Chilean colleagues, and (4) the authors gain important experience as they prepare to delve deeper into Santiago's air pollution problems.

7410 (LA-UR–93-4224) **Global atmospheric and ocean modeling on the connection machine.** Atlas, S.R. (Thinking Machines Corp., Cambridge, MA (United States)). Los Alamos National Lab., NM (United States). [1993]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9306285–1: North Atlantic Treaty Organization/Advanced Study Institute (NATO/ASI) workshop in high performance computing in geosciences, Chamouix (France), 21-25 Jun 1993). Order Number DE94003930. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes the high-level architecture of two parallel global climate models: an atmospheric model based on the Geophysical Fluid Dynamics Laboratory (GFDL) SKYHI model, and an ocean model descended from the Bryan-Cox-Semtner ocean general circulation model. These parallel models are being developed as part of a long-term research collaboration between Los Alamos National Laboratory (LANL) and the GFDL. The goal of this collaboration is to develop parallel global climate models which are modular in structure, portable across a wide variety of machine architectures and programming paradigms, and provide an appropriate starting point for a fully coupled model. Several design considerations have emerged as central to achieving these goals. These include the expression of the models in terms of mathematical primitives such as stencil operators, to facilitate performance optimization on different computational platforms; the isolation of communication from computation to allow flexible implementation of a single code under message-passing or data parallel programming paradigms; and judicious memory management to achieve modularity without memory explosion costs.

7411 (LRAP–133) **A differential optical absorption spectroscopy (DOAS) system for urban atmospheric pollution monitoring.** Edner, H.; Ragnarson, P.; Spaennare, S.; Svanberg, S. Lund Univ. (Sweden). Dept. of Physics. [1993]. 12p. Order Number DE94730427. Source: OSTI; NTIS.

We describe a fully computer-controlled differential optical absorption spectroscopy (DOAS) system for atmospheric air pollution monitoring. A receiving optical telescope can sequentially tune in to light beams from a number of distant high-pressure xenon lamp light sources to cover the area of a medium-sized city. A beam-finding servo system and automatic gain control allow unattended long-time monitoring. Using an astronomical code, celestial sources can also be searched and tracked. Selected wave-length regions are rapidly and repetitively swept by a monochromator to sensitively record the atmospheric absorption spectrum while avoiding the detrimental effects of atmospheric turbulence. By computer fitting to stored laboratory spectra the path-averaged concentration of a number of important pollutants such as NO_2, SO_2 and O_3 can be evaluated. 22 refs, 9 figs

7412 (NEI-DK–1387) **Substitution of CFC in release agents.** Arbejdsrapport fra Miljoestyrelsen, 54, Arbejdsrapport fra Miljoestyrelsen, 54. Olsen, I. (Direktoratet for Arbejdstilsynet (Denmark)); Olsen, E.; Overgaard Pedersen, J. Miljoestyrelsen, Copenhagen (Denmark). 1993. 102p. (In Danish). Order Number DE94730329. Source: OSTI; NTIS.

A working party, ultimately under the Danish Ministry of the Environment, has investigated the substitution of chlorofluorocarbons (CFC) in slip agents in connection with gasoline mixtures, refrigerators etc. and the aims and results of this investigation are here presented in detail. The feasibility of microemulsions, where water and carbon dioxide as extinguishing agents are built into pure organic solvent blends intended for slip agents, were examined as these are not inflammable. Flash-point determinations were carried out. Addition of 1,1-dichloro-1-fluoro ethane to the microemulsions was advantageous. The CFC materials used previously can be substituted with solvents but these have slower drying rates and have a flash point of over 55 degrees centigrade. Carbon dioxide can be sprayed under high pressure, allowing a reduction of solvent normally used and eliminating fire risk, but this is not economically feasible. It is claimed that the consumption of CFC used to produce slip agents has been reduced to zero since April 1993, due to statutory order and the work described in the report. (AB) (31 refs.)

7413 (NEI-DK–1391) **Indoor climate in buildings located on polluted ground: Measurement results and countermeasures.** Cowiconsult Raadgivende Ingenioerer A/S, Lyngby (Denmark). Apr 1992. 110p. (In Danish). Order Number DE94730327. Source: OSTI; NTIS.

Prepared for Bygge- og Boligstyrelsen.

In the case of buildings located on land polluted by rubbish dumps, industrial wastes, gasworks etc., it can be necessary to evaluate whether the indoor climate is influenced in such a way that it can constitute a health hazard to the occupants. A summary is presented of previous measurements carried out on indoor climates in 24 cases of buildings standing on polluted grounds. In addition, a description is given of a number of countermeasures that have been applied. (AB)

7414 (NEI-SE–128) **Volatile hazardous hydrocarbons in road tunnels, cars and smoky rooms.** Barrefors, G. Chalmers Univ. of Technology, Gothenburg (Sweden). Dept. of Chemical Environmental Science. 1993. 20p. Order Number DE94730407. Source: OSTI; NTIS; Available from: Chalmers Univ. of Technology, Dept. of Chemical Environmental Science, S-412 96 Gothenburg, Sweden.

Hazardous volatile hydrocarbons were determined in selected urban environments where many people are exposed to high concentration levels. Quantitative proportions of C_2-C_8 alkenes, alkadienes, alkynes, alkanes and arenes were determined for air polluted by vehicle exhaust or tobacco smoke. Samples were taken on adsorbent cartridges and analyzed by gas chromatography after thermal desorption and cryofocusing. The concentrations of total non-methane hydrocarbons in the Tingstad Tunnel in Gothenburg were found to be 800-4000 $\mu g/m^3$. These concentration levels are several times higher than those in a car in urban traffic. The high concentrations of benzene, ethene, and 1.3-butadiene, representing particular health hazards, are disquieting with regard to the present knowledge of the toxicity of these hydrocarbons. Current plans for new long road tunnels may be questioned with regard to the resulting increased exposure of motorist and passengers to air pollutants. Many volatile hydrocarbons found in environmental tobacco smoke are also present in vehicle exhaust in similar proportions. Urban air polluted by petrol-fuelled vehicles differs mainly by much lower proportions of isoprene and much higher proportions of petrol alkanes and alkylbenzenes. The total concentration of C_2-C_8 hydrocarbons was found to be similar in a smoky room and inside a car in urban traffic. 28 refs, 1 fig, 1 tab

7415 (NEI-SE–129) **Determination of volatile hydrocarbons in air.** Loefgren, L. Chalmers Univ. of Technology, Gothenburg (Sweden). Dept. of Chemical Environmental Science. 1990. 9p. (In Swedish). Order Number DE94730408. Source: OSTI; NTIS: Available from: Chalmers Univ. of Technology, Dept. of Chemical Environmental Science, S-412 96 Gothenburg, Sweden.

Environmentally important hydrocarbons in air were determined by sampling on selected adsorbents followed by thermal desorption and gas chromatography on suitable columns in the laboratory. The carcinogenic 1.3-butadiene and the four isomeric butenes were determined in the complex hydrocarbon mixture of petrol exhaust and petrol vapour in urban air. The concentration of butadiene, reflecting outdoor urban exposure, was in the range of 0.5-5 $\mu g/m^3$. Exposure levels of a suburban motorist was assessed for more than twenty volatile aromatic hydrocarbons from traffic exhaust. The levels were found to be 5-10 times higher than those of a train commuter. Comparisons in Switzerland and Sweden with differential optical absorption spectroscopy (DOAS) demonstrated this recently developed technique to be useful for continuous monitoring of benzene and toluene (above 10 $\mu g/m^3$) in moderately to heavily polluted urban air. The diffuse hydrocarbon emissions from the process area of a bitumen refinery were determined from vertical and horizontal concentration profiles across the emission

plume. The sum of the C_8-C_9 hydrocarbons made up 40% and the aromatic hydrocarbons made up 20% of the plume.

7416 (NEI-SE–130) **Terpenes emitted to air from forestry and the forest industry.** Stroemvall, A.M. Chalmers Univ. of Technology, Gothenburg (Sweden). Dept. of Chemical Environmental Science. 1992. 25p. Order Number DE94730409. Source: OSTI; NTIS; Available from: Chalmers Univ. of Technology, Dept. of Chemical Environmental Science, S-412 96 Gothenburg, Sweden.

The work reported in this thesis focuses on the poorly studied anthropogenic terpene emission from the industrial use of softwood. The advanced analytical determinations were made by adsorption sampling followed by thermal desorption and gas chromatography in the laboratory. Monoterpenes from forestry were analyzed for Scots pine (Pinus sylvestris) and Norway spruce (Picea abies). Near to a harvester, the total monoterpene concentrations reached $\approx$ 1000 $\mu g/m^3$, whereas the background level was $\approx$ 1 $\mu g/m^3$. Prominent monoterpenes were α-pinene, β-pinene, 3-carene, camphene, limonene, β-phellandrene, myrcene and terpinolene. Local formation of phytotoxic photooxidants may occur because of the short lifetimes of terpenes in air. Terpenes in process emissions and plumes from kraft pulp industries were found to have a uniform composition similar to that of pulpwood and of recovered sulphate turpentine. Predominant monoterpenes were α-pinene and 3-carene from Scots pine. The emitted terpenes give rise to photooxidants and to oxidation of co-emitted sulphur and nitrogen oxides. The monoterpenes in emissions from industries producing stone groundwood and thermomechanical pulp were similar in composition to that of the processed pulpwood from Norway spruce. The process emissions from a sulphite mill consisted mainly of p-cymene, formed from spruce monoterpenes by acid rearrangements. The terpene emissions from the barking of timber and pulpwood differed somewhat in composition from that of the wood. Oxidative decomposition and acid rearrangements of monoterpenes in the sampling cartridges were studied as major analytical difficulties. Pretreatment with thio sulphate and hydrogen carbonate prevented unwanted reactions of the terpenes. 62 refs

7417 (NILU-OR–27/93) **Monitoring of the ozone layer: A Norwegian and global perspective.** Stordal, F.; Braathen, G.O.; Dahlback, A. Norsk Inst. for Luftforskning, Lillestroem (Norway). Jul 1993. 11p. (In Norwegian). Order Number DE94730351. Source: OSTI; NTIS.

The observed reduction of stratospheric ozone is described. The focus is on global changes and changes over Europe and Norway. The development of the atmospheric contents of chlorine and bromine compounds, which deplete the ozone layer, is discussed. 10 refs., 5 figs., 2 tabs.

7418 (NUTEK–89-1791) **Exhaust gas emissions from sea transportation.** Alexandersson, A. (MariTerm AB, Gothenburg (Sweden)); Flodstroem, E.; Oeberg, R.; Staalberg, P. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden); Swedish Transport Research Board, Stockholm (Sweden). May 1991. 359p. (In Swedish). (TFB–91-18). Order Number DE94730443. Source: OSTI; NTIS.

The aim of the project has been to clarify the exhaust gas emissions of sea transportation, as regards quantity as well as type, and to relate this to the total emissions over Sweden. Different purification techniques have been studied and examples of ship-adapted exhaust purification have been worked out and presented. 77 refs, 60 figs, 45 tabs

7419 (PNL-SA–22351) **An overview of the ASCOT program.** Doran, J.C. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930810–13: Topical meeting on environmental transport and dosimetry, Charleston, SC (United States), 31 Aug - 3 sep 1993). Order Number DE94004356. Source: OSTI; NTIS; INIS; GPO Dep.

ASCOT (Atmospheric Studies in Complex Terrain) is a multilaboratory U.S. Department of Energy research program studying the properties of atmospheric boundary layers over non-uniform terrain and the interactions among various scales of motion that influence those properties. Within this context, one of the principal goals of the ASCOT program is to provide information necessary for an accurate description of transport and diffusion processes for atmosphere pollutants that may be released in regions of complex terrain. Three examples from past ASCOT research relevant to this goal are presented. Current and proposed research in the Front Range region of Colorado in the vicinity of the Rocky Flats Plant is also described.

7420 (SAND–93-2599C) **Trace organic chemical detection using an ultraviolet excitation molecular beam fluorometer.** Preppernau, B.L.; Hargis, P.J. Sandia National Labs., Albuquerque, NM (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940341–1: 4. laser applications to chemical analysis meeting, Jackson Hole, WY (United States), 8-11 Mar 1994). Order Number DE94002649. Source: OSTI; NTIS; GPO Dep.

Detection of air-borne environmental contaminants, such as organic solvents, requires unambiguous compound identification and sensitivity to concentrations below those permitted by regulating agencies. One promising detection approach uses a pulsed supersonic molecular beam vacuum expansion in combination with fluorescence signal spectral analysis to identify species in a chemical mixture. This report describes the use and performance of the ultraviolet excitation molecular beam fluorometer.

7421 (UCID–21336-Rev.1) **CHAWS user's guide: System description and standard operating procedures, Lexington-Blue Grass Army Depot.** Martins, S.A.; Shinn, J.H. (eds.). Lawrence Livermore National Lab., CA (United States). May 1993. 130p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94003668. Source: OSTI; NTIS; GPO Dep.

The Chemical Hazard Warning System (CHAWS) is designed to collect meteorological data and to display, in real time, the dispersion of hazardous chemicals that may result from an accidental release. Meteorological sensors have been placed strategically around the Lexington-Blue Grass Army Depot and are used to calculate direction and hazard distance for the release. Based on these data, arrows depicting the release direction and distance traveled are graphically displayed on a computer screen showing a site map of the facility. The objectives of CHAWS are as follows: To determine the trajectory of the center of mass of released material from the measured wind field; to calculate the dispersion of the released material based on the measured lateral turbulence intensity (sigma theta); to determine the height of the mixing zone by measurement of the inversion height and wind profiles up to an altitude of about 1 km at sites that have SODAR units installed; to archive meteorological data for potential use in climatological descriptions for emergency planning; to archive air-quality data for preparation of compliance reports; and to provide access to the data for near real time hazard analysis purposes. CHAWS sites are located at the Pine Bluff Arsenal, Arkansas, Edgewood area of Aberdeen Proving Ground, Maryland, Tooele Depot, Utah, Lexington-Blue Grass Depot, Kentucky, and Johnston Island in the Pacific. The systems vary between sites with different features and various types of hardware. The basic system, however, is the same. Nonetheless, we have tailored the manuals to the equipment found at each site.

7422 (UCRL-ID–112129-Rev.1) **The AFTAC model integration project: An annual progress report: Revision 1.** Rodriguez, D.J.; Moore, R.M. Lawrence Livermore National Lab., CA (United States). Dec 1993. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94005649. Source: OSTI; NTIS; GPO Dep.

The EXPRESS and ADPIC models have been designed to assist emergency personnel in their response to radiological accidents. Closure on the development of an operational version of the HADPIC Modeling System (HMS), a multi-faceted application that supports the hemispheric ADPIC (HADPIC) atmospheric dispersion model on a Sun workstation, was achieved toward the end of the fiscal year. The fulfilling tasks over the period encompassed by this report included: (1) the generation of software for calculating average concentrations at arbitrary locations in the model domain and displaying isopleths of concentration and (2) the comprehensive testing of major components of the HMS using IEEE standards.

Scientists for Lawrence Livermore National Laboratory and the Institute of Experimental Meteorology in Obninsk, Russia, extensively evaluated their respective models (ADPIC/U.S. and EXPRESS/Russia) using perfluorocarbon tracer data from the Across North America Tracer Experiment (ANATEX). The results of both models are reported here because of the useful insights they provide regarding limits of performance as a function of model sophistication and the quality of the input meteorology.

7423 (UCRL-JC–115045) **The technical basis for air pathway assessment of resuspended radioactive aerosols: LLNL experiences at seven sites around the world.** Shinn, J.H. Lawrence Livermore National Lab., CA (United States). Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-930914–1: The technical basis for measuring, modeling and mitigating toxic aerosols, Albuquerque, NM (United States), 26-30 Sep 1993). Order Number DE94003626. Source: OSTI; NTIS; GPO Dep.

There is a large uncertainty in quantifying the inhalation pathway and the aerosol emission rate in human health assessments of radioactive-contamination sites. The need for site-specific assessments led to formation of our team of specialists at LLNL, who have participated in numerous field campaigns around the world. Our goal was to obtain all the information necessary for determining potential human exposures and to estimate source terms for turbulent transport of the emissions during both normal and disturbed soil conditions. That is, measurements were made of the key variables to quantify the suspended aerosols at the actual contamination sites, but different scenarios for habitation, site management, and site cleanup were included. The most notable locations of these site-investigations were the Marshall Islands (Bikini, Enewetak, and Rongelap), Nevada Test Site (GMX, Little Feller, Palanquin, and Plutonium Valley), Tonopah (Nevada–site of Roller Coaster), Savannah River Lab (South Carolina–H-Area site), Johnston Island (cleanup of rocket-impact site), Chernobyl (Ukraine–grass field end sandy beach sites near Nuclear Power Plant Unit 4), and Palomares (Spain–site of aircraft accident). This discussion will review the variables quantified, methods developed, general results, uncertainty of estimations, and recommendations for future research that are a result of our experience in these field studies.

7424 (UCRL-JC–115085) **Evaluation of the Atmospheric Release Advisory Capability emergency response model for explosive sources.** Baskett, R.L.; Freis, R.P.; Nasstrom, J.S. Lawrence Livermore National Lab., CA (United States). 7 Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC08-93NV11265. (CONF-931117–1: 20. international technical meeting on air pollution modelling and its application, Valencia (Spain), 29 Nov - 3 dec 1993). Order Number DE94002986. Source: OSTI; NTIS; GPO Dep.

The Atmospheric Release Advisory Capability (ARAC) at the Lawrence Livermore National Laboratory (LLNL) uses a modeling system to calculate the impact of accidental radiological or toxic releases to the atmosphere anywhere in the world. Operated for the US Departments of Energy and Defense, ARAC has responded to over 60 incidents in the past 18 years, and conducts over 100 exercises each year. Explosions are one of the most common mechanisms by which toxic particulates are injected into the atmosphere during accidents. Automated algorithms with default assumptions have been developed to estimate the source geometry and the amount of toxic material aerosolized. The paper examines the sensitivity of ARAC's dispersion model to the range of input values for explosive sources, and analyzes the model's accuracy using two field measurement programs.

7425 (UCRL-LR–115188) **Radiological analysis of the National Ignition Facility.** Singh, M.S. Lawrence Livermore National Lab., CA (United States). 26 Oct 1993. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004272. Source: OSTI; NTIS; INIS; GPO Dep.

The National Ignition Facility (NIF) will be capable of providing a laser output pulse at 0.35 μm wavelength with an energy of 1.8 MJ and a power of 500 TW. The NIF will house a multi-beamline, Nd-doped-glass laser capable of delivering such pulses into a target chamber. In the target chamber, a positioner will center a target containing fusion fuel (a deuterium-tritium mixture) for each ignition shot. Diagnostics in the chamber will provide the test data (e.g., neutron and x-ray yields). The NIF baseline case would result in deuterium-tritium (DT) neutron yields of about 10^{16} to 10^{19} per fusion shot. The baseline fusion shots would use 2 Ci of tritium per capsule, with an annual input of about 600 Ci (60 mg). The resulting anticipated annual airborne emissions would consist of approximately 10 Ci of tritium and small amounts of activated air species. The NEF shielding configuration would limit the direct and skyshine radiation intensities around the facility to less than 0.1 rem/y on site and to less than 0.001 rem/y off site. This report presents the results of atmospheric transport calculations for tritium and activated air emissions; neutron and secondary gamma-ray shielding calculations; and results of benchmark studies for validating the EPA CAP88-PC code (for the transport of tritium) and the Lawrence Livermore National Laboratory neutron-photon transport code TART. All calculations were normalized to the annual baseline case of 1.4×10^{20} DT-fusion neutrons. Tritium emissions were normalized to 10 Ci/y. Radiological analyses show that normal NIF operations would result in off-site radiation intensities that would represent insignificant increases over the natural background radiation intensity. The NIF is a national facility, and the DOE has not completed the site evaluation process. Although the results presented in this report are for LLNL, the analytical approach is applicable to any site.

7426 (WHC-SD-W026-TA–001) **Technical Assessment: WRAP 1 HVAC Passive Shutdown.** Ball, D.E.; Nash, C.R.; Stroup, J.L. Westinghouse Hanford Co., Richland, WA (United States). 12 Aug 1993. 76p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94003529. Source: OSTI; NTIS; INIS; GPO Dep.

As the result of careful interpretation of DOE Order 6430.IA and other DOE Orders, the HVAC system for WRAP 1 has been greatly simplified. The HVAC system is now designed to safely shut down to Passive State if power fails for any reason. The fans cease functioning, allowing the Zone 1 and Zone 2 HVAC Confinement Systems to breathe with respect to atmospheric pressure changes. Simplifying the HVAC system avoided overdesign. Construction costs were reduced by eliminating unnecessary equipment. This report summarizes work that was done to define the criteria, physical concepts, and operational experiences that lead to the passive shutdown design for WRAP 1 confinement HVAC systems.

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Refer also to citation(s) 6108, 6153, 6154, 6156, 6179, 6185, 6190, 6192, 6195, 6197, 6198, 6201, 6205, 6208, 6226, 6236, 6237, 6238, 6239, 6243, 6245, 6246, 6247, 6248, 6249, 6250, 6252, 6253, 6258, 6260, 6265, 6266, 6267, 6270, 6273, 6279, 6281, 6282, 6283, 6288, 6290, 6296, 6297, 6300, 6790, 6793, 7089, 7117, 7329, 7393, 7410, 7413, 7423, 7477, 7499, 7518, 7914, 7919

7427 (ANL/EA/CP–79950) **Estimating baseline risks from biouptake and food ingestion at a contaminated site.** MacDonell, M.; Woytowich, K.; Blunt, D.; Picel, M. Argonne National Lab., IL (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931095–65: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94003218. Source: OSTI; NTIS; INIS; GPO Dep.

Biouptake of contaminants and subsequent human exposure via food ingestion represents a public concern at many contaminated sites. Site-specific measurements from plant and animal studies are usually quite limited, so this exposure pathway is often modeled to assess the potential for adverse health effects. A modeling tool was applied to evaluate baseline risks at a contaminated site in Missouri, and the results were used to confirm that ingestion of fish and game animals from the site area do not pose a human health threat. Results were also used to support the development of cleanup criteria for site soil.

7428 (ANL/EAD/TM–2) **Adaptive sampling strategy support for the unlined chromic acid pit, chemical waste landfill,**

Sandia National Laboratories, Albuquerque, New Mexico. Johnson, R.L. Argonne National Lab., IL (United States). Nov 1993. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94004538. Source: OSTI; NTIS; GPO Dep.

Adaptive sampling programs offer substantial savings in time and money when assessing hazardous waste sites. Key to some of these savings is the ability to adapt a sampling program to the real-time data generated by an adaptive sampling program. This paper presents a two-prong approach to supporting adaptive sampling programs: a specialized object-oriented database/geographical information system (SitePlanner™) for data fusion, management, and display and combined Bayesian/geostatistical methods (PLUME) for contamination-extent estimation and sample location selection. This approach is applied in a retrospective study of a subsurface chromium plume at Sandia National Laboratories' chemical waste landfill. Retrospective analyses suggest the potential for characterization cost savings on the order of 60% through a reduction in the number of sampling programs, total number of soil boreholes, and number of samples analyzed from each borehole.

7429 (BNL–49709) **In-situ containment and stabilization of buried waste: Annual report FY 1993.** Allan, M.L.; Kukacka, L.E. Brookhaven National Lab., Upton, NY (United States). Oct 1993. 94p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE94005145. Source: OSTI; NTIS; INIS; GPO Dep.

In FY 1993 research continued on development and testing of grout materials for in-situ containment and stabilization of buried waste. Specifically, the work was aimed at remediation of the Chemical Waste Landfill (CWL) at Sandia National Laboratories (SNL) in Albuquerque, New Mexico as part of the Mixed Waste Landfill Integrated Demonstration (MWLID). The work on grouting materials was initiated in FY 1992 and the accomplishments for that year are documented in the previous annual report (Allan, Kukacka and Heiser, 1992). The remediation plan involves stabilization of the chromium plume, placement of impermeable vertical and horizontal barriers to isolate the landfill and installation of a surface cap. The required depth of subsurface barriers is approximately 33 m (100 ft). The work concentrated on optimization of grout formulations for use as grout and soil cement barriers and caps. The durability of such materials was investigated, in addition to shrinkage cracking resistance, compressive and flexural strength and permeability. The potential for using fibers in grouts to control cracking was studied. Small scale field trials were conducted to test the practicality of using the identified formulations and to measure the long term performance. Large scale trials were conducted at Sandia as part of the Subsurface Barrier Emplacement Technology Program. Since it was already determined in FY 1992 that cementitious grouts could effectively stabilize the chromium plume at the CWL after pre-treatment is performed, the majority of the work was devoted to the containment aspect.

7430 (CONF-9307141–1) **Direct Sampling Ion Trap Mass Spectrometry.** Thompson, C.V.; Wise, M.B.; Buchanan, M.V.; Guerin, M.R. Oak Ridge National Lab., TN (United States). [1993]. 17p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC05-84OR21400. From Mobile Analytical Laboratory workshop; Los Alamos, NM (United States); 20-21 Jul 1993. Order Number DE93040606. Source: OSTI; NTIS; GPO Dep.

This presentation describes the development and field testing of Direct Sampling Ion Trap Mass Spectrometry (DSITMS) for the rapid analysis of volatile organics in air, water, and soil, with an emphasis on the fieldable version of the instrumentation. Direct Sampling Ion Trap Mass Spectrometry (DSITMS) has been developed in our laboratory to provide faster and less costly methods for the screening and analysis of environmental samples. "Direct sampling" involves the introduction of analytes directly into the mass spectrometer with no sample preconcentration and little or no sample preparation. Analytes can be monitored in real-time or near real-time at low part-per-billion (ppb) levels with analysis times ranging from instantaneous to approximately 3 minutes, depending on the sample matrix, the degree of specificity, and the level of quantification required. Particular attention has been given to developing instrumentation which is suitable to field applications. This includes applicability in mobile laboratories and stand-alone vehicle transportation. This paper summarizes the characteristics of DSITMS and describes currently developed instrumentation.

7431 (DOE/EA–0860) **Construction of a Solid State Research Facility, Building 3150: Environmental Assessment.** Oak Ridge National Lab., TN (United States). Jul 1993. 15p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94001262. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy (DOE) proposes to construct a new facility to house the Materials Synthesis Group (MSG) and the Semiconductor Physics Group (SPG) of the Solid State Division, Oak Ridge National Laboratory (ORNL). The location of the proposed action is Roane County, Tennessee. MSG is involved in the study of crystal growth and the preparation and characterization of advanced materials, such as high-temperature superconductors, while SPG is involved in semiconductor physics research. All MSG and a major pardon of SPG research activities are now conducted in Building 2000, a deteriorating structure constructed in the 1940. The physical deterioration of the roof; the heating, ventilation, and air conditioning (HVAC) system; and the plumbing make this building inadequate for supporting research activities. The proposed project is needed to provide laboratory and office space for MSG and SPG and to ensure that research activities can continue without interruption due to deficiencies in the building and its associated utility systems.

7432 (DOE/ER/60581–6) **Effects of vegetation of radon transport processes in soil: The origins and pathways of ^{222}Rn entering into basement structures: Final report, March 15, 1987–May 15, 1993.** Borak, T.B. Colorado State Univ., Fort Collins, CO (United States). Aug 1992. 166p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-87ER60581. Order Number DE94001797. Source: OSTI; NTIS; GPO Dep.

The entry rate of ^{22}Rn into a basement structure was measured continuously. These measurements demonstrated that radon entry did not vanish even when the structure was slightly pressurized. This persistent entry has been determined to be dominated by diffusion through the floor and walls and a combination of diffusion and convection through the floor-wall joint. The highest indoor radon concentrations occurred during calm periods when the pressure differentials between the inside and outside of the structure were small. The objectives of this work were to identify the origins of the radon and investigate the entry pathways. The radon could originate either in the concrete or in the soil surrounding the structure. Entry pathways into the basement were through the concrete floor and walls as well as through the floor-wall joint. The contributions of the origins and entry pathways were determined by continuously measuring the radon entry rate into the basement, using a trace gas system, and the flux density through portions of the floor and walls. Radon entry through the floor-wall joint could be controlled using a baseboard barrier system. Results indicated that, during calm conditions with wind speeds less than 1 m s^{-1}, 25 % of the radon enters through the floor-wall joint and 75 % enters through the concrete. About 30 % of the radon originated in the concrete floor and walls. A method for in-situ determination of the diffusion length and emanation fraction of radon in concrete was developed. For the concrete used in the structure, the average diffusion length and emanation fraction were 27 ± 4 cm and 0.19 ± 0.02 respectively.

7433 (DOE/ER/60844–3) **Experimental assessment and modeling of interphase mass transfer rates of organic compounds in multiphase subsurface systems: Final report, July 1, 1989–June 30, 1993.** Abriola, L.M.; Weber, W.J. Jr. Michigan Univ., Ann Arbor, MI (United States). Oct 1993. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER60844. Order Number DE94003983. Source: OSTI; NTIS; GPO Dep.

Results of an experimental investigation into strady state dissolution of nonaqueous phase liquids (NAPLS) entrapped within water saturated porous media are presented. Influence of porous media type, NAPL characteristics, and aqueous phase flow velocity are examined for transient and steady-state dissolution of NAPL.

Entrapped NAPL distributions are examined and are found to influence mass transfer between the phases. A phenomenological model for the steady state mass transfer process is developed which expresses a lumped mass transfer coefficient as a function of the hydrodynamics of the system and grain size parameters as a surrogate measure of the NAPL distribution. Transient dissolution data is used to develop two alternative phenomenological models for mass transfer. The models are incorporated into a onedimensional numerical simulator and are shown to be effective predictors of transient dissolution data in similar experimental systems. In order to further explore the effects of scale and heterogeneities on NAPL dissolution, the sphere model is incorporated into a twodimensional simulator and is used to explore long-term dissolution of a TCE (trichloroethylene) spill in a layered system of sands. The simulation demonstrates the significance of heterogeneity, both in controlling the initial distribution of NAPL and the rate of NAPL dissolution.

7434 (DOE/FTR–93018762) **Travel to Vienna, Austria for meeting on modelling radionuclide transfer in the environment: Foreignn trip report, March 1–9, 1991.** Templeton, W.L. Pacific Northwest Lab., Richland, WA (United States). 5 Apr 1991. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE93018762. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The purpose of this travel was to the "Validation of Models for the Transfer of Radionuclides in Terrestrial, Aquatic and Urban Environments," research coordination meeting. The traveler also attended a meeting of the International Union of Radioecologists Environmental Modelling Working Group, and a meeting of contractors to the Commission for European Communities Radiation Protection Program.

7435 (DOE-HMIP-RR–93.026) **Evaluation of host rocks and background lithologies as secondary contributors to the uranium and rare-earth element source-term at the Needle's Eye natural analogue site.** Hyslop, E.K. (British Geological Survey, Edinburgh (United Kingdom). Mineralogy and Petrology Group); Pearce, J.M. Department of the Environment, London (United Kingdom). Her Majesty's Inspectorate of Pollution. 1993. 46p. (BGS-TR-WE–92/32.). Order Number DE94610460. Source: OSTI; NTIS (US Sales Only); INIS.

HMIP has a research programme investigating some naturally radioactive sites in the UK as geochemical analogues of radionuclide migration. The objective is to test thermodynamic database and computer codes used for modelling radionuclide migration under environmental conditions. This report describes a study of the distributions of uranium (U) and the rare-earth elements (REE) in the vicinity of pitchblende veins outcropping in the cliff at Needle's Eye on the Solway Coats, SW Scotland. This report improves the information available on the secondary source-terms of U and REE. The minerals in the country rocks are thought to be supplying only minor amounts of these elements to the groundwaters flowing into the Merse silts within the detailed study area close to the mineralisation in the cliff. The pitchblende veins are the principal source-term for U migrating into the Merse silts at the foot of the cliff. (author).

7436 (DOE/MC/29119–3524) **Innovative directional and position specific sampling technique: Phase I: Final report, July 28, 1992–April 28, 1993.** Hutzel, W.J.; Foster, E.L. UTD, Inc., Newington, VA (United States). Apr 1993. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-92MC29119. Order Number DE94000049. Source: OSTI; NTIS; INIS; GPO Dep.

UTD, Incorporated has developed a unique real-time, in-situ POsition LOcation (POLO) device which will directly enhance the DOE Environmental Restoration and Waste Management Program through improvements to finding contamination, identifying extent of contamination, remediating, and finally monitoring sites. POLO is smaller than existing technology and is unaffected by the presence of steel and other magnetic materials. The size of the device offers for the first time, the possibility to accurately determine the location of a penetrometer. It will be usable, in its present form, to map the position of a sampling device as that device is inserted into the hole. A three phase program with a 21 month period of performance was proposed to DOE to take the POLO system through the three levels of maturity prior to commercialization. The goal of Phase I of the contract, "Innovative and Position Specific Sampling Technique" was to analyze, test, and refine the individual subsystems of the POLO system. The goals were accomplished and the success criteria met by engineering design and precision construction of the various system components. A prototype module was designed, constructed, and calibrated. The final report presented here details the design, manufacture, and testing of each POLO component (sub-scale) in an experimental configuration. A comprehensive error analysis summarizes the performance and demonstrates that all project goals have been met. Plans for commercialization of POLO are discussed and highlight the expected smooth transition to full scale production.

7437 (DOE/NV/10630–66-Vol.1) **US Department of Energy Nevada Operations Office annual site environmental report, 1992: Volume 1.** Black, S.C.; Latham, A.R.; Townsend, Y.E. (eds.). Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (United States). Sep 1993. 350p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-89NV10630. Order Number DE94003235. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains the environmental monitoring and assessment results for the Nevada Test Site for 1992. Monitoring and surveillance on and around the NTS by DOE contractors and Site user organizations during 1992 indicated that underground nuclear testing operations were conducted in compliance with regulations, i.e., the dose the maximally exposed offsite individual could have received was less than 0.15 percent of the guideline for air exposure. All 1992 nuclear events took place during the first three quarters of the calendar year prior to the Congressional testing moratorium. All discharges of radioactive liquids remained onsite in containment ponds, and there was no indication of potential migration of radioactivity to the offsite area through groundwater. Surveillance around the NTS indicated that airborne radioactivity from test operations was not detectable offsite, and no measurable net exposure to members of the offsite population was detected through the offsite dosimetry program. Using the CAP88-PC model and NTS radionuclide emissions data, the calculated maximum effective dose equivalent offsite would have been 0.012 mrem. Any person receiving this dose was also exposed to 78 mrem from natural background radiation. There were no nonradiological releases to the offsite area. Hazardous wastes were shipped to EPA-approved disposal facilities. Compliance with the various regulations stemming from the National Environmental Policy Act is being achieved and, where mandated, permits for air and water discharges and waste management have been obtained from the appropriate agencies. Non-NTS support facilities complied with the requirements of air quality permits and state or local wastewater discharge and hazardous waste permits.

7438 (DOE/NV/10630–66-Vol.2) **US Department of Energy Nevada Operations Office annual site environmental report, 1992: Volume 2, Appendices.** Black, S.C.; Latham, A.R.; Townsend, Y.E. (eds.). Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (United States). Sep 1993. 375p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-89NV10630. Order Number DE94003236. Source: OSTI; NTIS; INIS; GPO Dep.

These appendices contain 1992 NTS onsite and offsite environmental monitoring results. The onsite data presented are accompanied by summaries of statistical evaluations of the data. Other offsite data collected by the EPA are available from the US Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

7439 (DOE/OR/00033–T543) **Population differentiation in tree-ring growth response of white fir (Abies concolor) to climate: Implications for predicting forest responses to climate change.** Jensen, D.B. Oak Ridge Inst. for Science and Education, TN (United States); California Univ., Berkeley, CA (United States). [1993]. 143p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE94000837. Source: OSTI; NTIS; GPO Dep.

Forest succession models and correlative models have predicted 200–650 kilometer shifts in the geographic range of temperate forests and forest species as one response to global climate change. Few studies have investigated whether population differences may effect the response of forest species to climate change. This study examines differences in tree-ring growth, and in the phenotypic plasticity of tree-ring growth in 16-year old white fir, Abies concolor, from ten populations grown in four common gardens in the Sierra Nevada of California. For each population, tree-ring growth was modelled as a function of precipitation and degree-day sums. Tree-ring growth under three scenarios of doubled $C0_2$ climates was estimated.

7440 (DOE/OR/00033–T555) **A correlation between soil descriptions and ^{226}Ra concentrations in Florida soils.** Harrison, D.P. Oak Ridge Inst. for Science and Education, TN (United States). 1992. 75p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE94000849. Source: OSTI; NTIS; GPO Dep.

The soil radium content in Florida is highly variable. The range in radium concentrations, where the samples involved in this study are concerned, is from 0.1 pCi/g to 18.5 pCi/g. Low ^{226}Ra concentrations (0.1 to 5 pCi/g) are evidenced in sands, moderate concentrations (5 to 11 pCi/g) are found in silt and gravel, and high ^{226}Ra concentrations (>11 pCi/g) are found in soil horizons with shell, clay, and strata with phosphate. Strata containing phosphate yields a high concentration of ^{226}Ra. The information obtained in this study, soil descriptions with their corresponding ^{226}Ra concentrations, comes from geological cores drilled by geotechnical consultants with gamma spectrometry analysis performed by high resolution gamma spectroscopy. Concentration; of ^{226}Ra generally increase with depth. These cores are usually terminated at 20 feet deep, with some cores being shallower than this due to hitting bedrock or encountering the water table. These frequency distributions give the core-logging geologist an approximate concentration of ^{226}Ra based on the description of the soil. Since the correlation of ^{226}Ra and soil descriptions can be used as a tool in assigning indoor radon potential, this study is of importance to land managers, contractors, developers, and regulating agencies who are attempting to place standards on tracts of land with ^{226}Ra concentration used as a criterion.

7441 (DOE/OR/00033–T569) **A study of radon-222 concentrations in North Carolina groundwater.** Evans, J.P. Oak Ridge Associated Universities, Inc., TN (United States); North Carolina Univ., Chapel Hill, NC (United States). 1992. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE94001412. Source: OSTI; NTIS; INIS; GPO Dep.

The groundwater of 400 North Carolina homes was sampled to ascertain the distribution and extent of ^{222}Rn in North Carolina groundwater. Arithmetic mean (AM) and geometric mean (GM) concentrations of 1,816 pCi L^{-1} and 656 pCi L^{-1} were found for the state. These results indicate that two-thirds of 114°C. homes served by groundwater exceed the EPA proposed 300 pCi L^{-1} maximum contaminant level (MCL). Only 2% of NC homes exceeded 10,000 pCi L-1. The Eastern region had the lowest radon concentrations by far, with a GM of 2-)0 pCi L^{-1}. The Central region and Western region had GM's of 794 pCi L^{-1} and 1,032 pCi L^{-1} respectively. The groundwater data approached a log normal distribution. No consistent trends were noted in the relationship between indoor radon concentrations and groundwater radon concentrations. A correlation coefficient of 0.00921 revealed a very weak linear relationship.

7442 (DOE/RL–89-12-Rev.1) **Hanford Site Groundwater Protection Management Program: Revision 1.** Westinghouse Hanford Co., Richland, WA (United States). Nov 1993. 82p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94005512. Source: OSTI; NTIS; INIS; GPO Dep.

Groundwater protection is a national priority that is promulgated in a variety of environmental regulations at local, state, and federal levels. To effectively coordinate and ensure compliance with applicable regulations, the US Department of Energy has issued DOE Order 5400.1 (now under revision) that requires all US Department of Energy facilities to prepare separate groundwater protection program descriptions and plans. This document describes the Groundwater Protection Management Program for the Hanford Site located in the state of Washington. DOE Order 5400.1 specifies that the Groundwater Protection Management Program cover the following general topical areas: (1) documentation of the groundwater regime, (2) design and implementation of a groundwater monitoring program to support resource management and comply with applicable laws and regulations, (3) a management program for groundwater protection and remediation, (4) a summary and identification of areas that may be contaminated with hazardous waste, (5) strategies for controlling these sources, (6) a remedial action program, and (7) decontamination and decommissioning and related remedial action requirements. Many of the above elements are covered by existing programs at the Hanford Site; thus, one of the primary purposes of this document is to provide a framework for coordination of existing groundwater protection activities. Additionally, it describes how information needs are identified and can be incorporated into existing or proposed new programs. The Groundwater Protection Management Program provides the general scope, philosophy, and strategies for groundwater protection/management at the Hanford Site. Subtier documents provide the detailed plans for implementing groundwater-related activities and programs. Related schedule and budget information are provided in the 5-year plan for environmental restoration and waste management at the Hanford Site.

7443 (EML–557) **In situ gamma-ray spectrometry: A tutorial for environmental radiation scientists.** Miller, K.M.; Shebell, P. USDOE Environmental Measurements Lab., New York, NY (United States). Oct 1993. 45p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003691. Source: OSTI; NTIS; INIS; GPO Dep.

This tutorial is intended for those in the environmental field who perform assessments in areas where there is radioactive contamination in the surface soil. Techniques will be introduced for performing on-site quantitative measurements of gamma radiation in the environment using high resolution germanium detectors. A basic understanding of ionizing radiation principles is assumed; however, a detailed knowledge of gamma spectrometry systems is not required. Emphasized is the practical end of operations in the field and the conversion of measured full absorption peak count rates in a collected spectrum to meaningful radiological quantities, such as the concentration of a radionuclide in the soil, activity per unit area, and dose rate in the air. The theory of operation and calibration procedures will be covered in detail to provide the necessary knowledge to adapt the technique to site-specific problems. Example calculations for detector calibration are also provided.

7444 (INIS-mf–13733) **Activity report 1990-1992 and proceedings. Volume I.** Mayer-Rosa, D.; Waniek, L.; Suhadolc, P. Ceskoslovenska Akademie Ved, Prague (Czech Republic). Geofyzikalni Ustav. 1993. 247p. (CONF-9209428–: 23. general assembly of the European Seismological Commission, Prague (Czech Republic), 7-12 Sep 1992). Order Number DE94610480. Source: OSTI; NTIS (US Sales Only); INIS.

A report on the activities of the European Seismological Commission (ESC) during the period 1990-1992 together with the Proceedings of the General Assembly of theESC are presented in two volumes. Volume I covers the following topics: recent strong earthquakes in Europe, regional seismicity, historical earthquakes in Europe, statistical models and methods in seismology, numerical modelling in three-dimensional media, methodology of quantification of European earthquakes and recent results, seismic noise and signal detectability, regional seismic network and history of seismometry. One paper dealing with microseismic noise characteristics around the Kozloduy nuclear power plant has been inputted to INIS. (Z.S.).

7445 (INIS-mf–13733, pp. 167-170) **Investigation of spectral and spatial microseismic noise characteristics around Kozloduy NPP (Bulgaria).** Ouzounov, D. (Bulgarian Academy of Sciences, Sofia (Bulgaria). Geophysical Institute); Dineva, S.; Michailov, D.; Petrov, L. Ceskoslovenska Akademie Ved, Prague (Czech Republic). Geofyzikalni Ustav. 1993. (CONF-9209428–: 23. general assembly of the European Seismological Commission,

Prague (Czech Republic), 7-12 Sep 1992). In *Activity report 1990-1992 and proceedings. Volume I: Proceedings.* 247p. Order Number DE94610480. Source: OSTI; NTIS (US Sales Only); INIS.

Microseismic noise (MSN) characteristics were studied in the vicinity of the Kozloduy nuclear power plant NPP. The observations were performed using the noise tomography method at 25 different points in the 50-km area south of the plant. Short-period three-component digital recordings (0.2-25 Hz) with a duration of 300 s and sample rate of 50 Hz were performed. The results on MSN frequency and spatial characteristics show the absence of large heterogeneity structures within the radius of 50 km from the Kozloduy plant; this is consistent with all available geophysical information about the region investigated. (Z.S.) 1 tab., 7 figs., 5 refs.

7446 (INIS-mf–13734) **Activity report 1990-1992 and proceedings. Volume II.** Mayer-Rosa, D.; Waniek, L.; Suhadolc, P. Ceskoslovenska Akademie Ved, Prague (Czech Republic). Geofyzikalni Ustav. 1993. 213p. (CONF-9209428–: 23. general assembly of the European Seismological Commission, Prague (Czech Republic), 7-12 Sep 1992). Order Number DE94610481. Source: OSTI; NTIS (US Sales Only); INIS.

A report of the European Seismological Commission (ESC) on 1990-1992 activities and Proceedings of the General Assembly of the ESC are presented in two volumes. Volume II covers the following topics: study of seismic sound, seismotectonic analysis, deep seismic sounding, the three-dimensional structure of the European lithosphere-asthenosphere system, complexity in earthquake occurrence, earthquake hazard, strong and weak earthquake ground motions, macroseismology, microzonation, and applications in earthquake engineering. One paper dealing with the connection between seismicity and the CO_2-^{222}Rn content in spring water has been inputted to INIS. (Z.S.).

7447 (INIS-mf–13759) **Transuranium elements leaching from simulated HLW glasses in synthetic interstitial claywater.** Wang, L. Louvain Univ. (Belgium). Aug 1992. 96p. Order Number DE94610461. Source: OSTI; NTIS (US Sales Only); INIS.

The main objective of this Master Thesis is to measure the steady-state concentrations of Pu, Np, and Am upon the leaching of High-Level Waste Glass in two types of synthetic claywater: humic acid free and humic acid containing synthetic claywater. The synthetic claywater has a composition that is representative for the in-situ interstitial groundwater of the Boom clay formation, a potential geological repository of radioactive waste in Belgium. The steady-state concentrations of transuranium elements were measured by leaching experiments with a typical duration of 400 days. Five main conclusions are drawn from the experimental data. (1) The transuranium elements that are released from simulated High Level Waste Glass are dominantly present in the synthetic claywater solutions as colloids. These colloids are smaller than 2 nm in absence of humic acids. In the presence of humic acids however, the colloids interact with actinides (adsorb or coagulate) and form particles larger than 2 nm. Np and Am are associated with inorganic and organic colloids in the synthetic interstitial claywater solution whereas Pu forms only inorganic colloids. (2) The steady-state concentration of Pu is in good agreement with the solubility of the Pu compound $PuO_2.xH_2O$. It is therefore concluded that $PuO_2.xH_2O$ is the solubility controlling phase. (3) The Pu(IV)-species are dominant in the leaching solutions. Carbonate and humic acid complexes are negligible. (4) The steady-state concentrations of Np and Am in leaching solutions were much lower than the values calculated on the basis of known thermodynamic data. This indicates that the solubility controlling phases for Np and Am were not correctly identified or that the measured Np and Am concentrations were not steady-state values. (5) Non-active glass leaching tests have indicated that no organic colloids were formed as a result of glass dissolution. (A.S.).

7448 (Juel–2760) **Measuring program of the Federal Republic of Germany: Results of the environment measurements in Russia, Belarus and Ukraine from May 12 to September 26, 1992.** Heinemann, K.; Hille, R. Forschungszentrum Juelich GmbH (Germany). Abt. Sicherheit und Strahlenschutz. May 1993. 115p. (In German). Order Number DE94734098. Source: OSTI; NTIS (US Sales Only); INIS.

21 scientists and engineers conducted environmental measurement and determined the contamination of soil and foodstuff. Samples of food of the population were measured received and the results were given in a certificate with short explanation in the native language. In 3 appendices of this report all results are given in detail. They are discussed in the way of local mean values. In regard to one year earlier the external dosis and the soil contaminations are nearly constant. But the milk contaminations decreased significantly. (orig.)

7449 (KFK–5154) **Contaminated soils and treatment technologies from the chemist's point of view (a summary of literature).** Boukis, N. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Heisse Chemie; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Schadstoff- und Abfallarme Verfahren (PSA). Jan 1993. 101p. (In German). Order Number DE94733997. Source: OSTI; NTIS (US Sales Only).

The aim of this study is to provide the reader with some general informations and a comprehensive bibliography about the following subjects: contaminated soils in general, types of soils and their components, common contaminants, their analysis and upper limit values, and technologies of treatment of contaminated soils. (orig.)

7450 (LA-UR–93-3992) **The Nevada Test Site: An analog for a nuclear repository.** Thompson, J.L. Los Alamos National Lab., NM (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931201–3: 4. international conference on chemistry and migration behavior of actinides and fission products in the geosphere, Charleston, SC (United States), 12-17 Dec 1993). Order Number DE94003956. Source: OSTI; NTIS; INIS; GPO Dep.

The United States proposes to store high level nuclear wastes underground; a site at Yucca Mountain in southern Nevada is currently under evaluation. A major concern is that radioactive materials may dissolve in the groundwater and be transported to the accessible environment. At the Nevada Test Site (NTS) adjacent to Yucca Mountain underground nuclear tests have been conducted for over 30 years. Radionuclides (unreacted fissile material, activation products, fission products) from these tests remain underground with no confinement by engineered barriers. The US Department of Energy has supported studies since 1973 designed to measure the distribution of these radionuclides and to evaluate the processes by which they might be transported by groundwater. The authors describe here some of what they have learned about how radionuclides are distributed around nuclear test cavities and how they interact with groundwater.

7451 (LBL–34460) **Design calculations for a combined ventilation and brine injection experiment at the Grimsel Rock Laboratory, Switzerland.** Finsterle, S.; Pruess, K. Lawrence Berkeley Lab., CA (United States). Jul 1993. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94004936. Source: OSTI; NTIS; INIS; GPO Dep.

A combined ventilation and brine injection test is planned at the Grimsel Test Site. The objective of the experiment is to study the transport of liquid and gas in the vicinity of a ventilated drift in order to evaluate the impact of the drying process on the characterization of the rock matrix. The proposed test sequence includes a desaturation-resaturation cycle. In addition, brine and fresh water will be injected from a borehole as trace electrolytes in order to better track the propagation of the individual phases. Results of design calculations using the TOUGH2 code show that injection of brine may significantly influence the unsaturated flow behavior by changing the pressure and saturation distribution around the borehole. Transport velocity is predicted to be very slow, requiring several months for the brine to reach the draft wall. However, the presence of preferential flow paths may reduce travel time and alter brine content and saturation distribution so that certain sensors may respond earlier or not at all.

7452 (LBL–34838) **Hydrogeologic characterization of a fractured granitic rock aquifer, Raymond, California.** Cohen, A.J.B. Lawrence Berkeley Lab., CA (United States). Oct 1993. 108p. Sponsored by USDOE, Washington, DC (United States);Environmental Protection Agency, Washington, DC (United

States). DOE Contract AC03-76SF00098. Order Number DE94005205. Source: OSTI; NTIS; GPO Dep.

The hydrogeologic properties of a shallow, fractured granitic rock aquifer in the foothills of the Sierra Nevada, California were investigated via the analysis of borehole geophysical logs and pumping tests. The drawdowns produced during these tests are not indicative of any simple conceptual aquifer model, and borehole logs show that the granite is intensely fractured. These observations are suggestive of a complex fracture-flow geometry which is extremely difficult to decipher. However, through the measurement of orientations of individual subsurface fractures from acoustic televiewer logs, and correlation between particular fractures and electrical resistivity and thermal-pulse flowmeter logs, it was found that the aquifer is, in general, comprised of two subhorizontal and nearly parallel zones of unloading fractures. Downhole flowmeter measurements taken in several wells provide further evidence for the inferred dual-layer structure of the aquifer, as well as yield quantitative measures of the contribution of flow from each zone. Analysis of drawdowns in pumped wells reveals that there are zones of relatively high transmissivity immediately around them. It was found that these properties, as well as a nearby zone of lower transmissivity, can account for their observed drawdowns. A numerical model was constructed to test whether these major heterogeneities could also account for the drawdowns in observation wells. This stepwise analysis of both the geophysical and hydrological data resulted in the formulation of a conceptual model of the aquifer which is consistent with observations, and which can account for its behavior when subjected to pumping.

7453 (PNL–8935) **Plant reestablishment after soil disturbance: Effects of soils, treatment, and time.** Brandt, C.A.; Alford, K.; McIlveny, G.; Tijerina, A. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94003677. Source: OSTI; NTIS; INIS; GPO Dep.

The Pacific Northwest Laboratory examined plant growth and establishment on 16 sites where severe land disturbance had taken place. The purpose of the study was to evaluate the relative effectiveness of the different methods in term of their effects on establishment of native and alien plants. Disturbances ranged from 1 to 50 years in age. Revegetation using native plants had been attempted at 14 of the sites; the remainder were abandoned without any further management. Revegetation efforts variously included seeding, fertilizer application, mulching with various organic sources, compost application, application of Warden silt loam topsoil over sand and gravel soils, and moderate irrigation.

7454 (PNL–8945) **Conversion of Hanford site well locations to Washington coordinate system of 1983, South Zone 1991 (WCS83S).** Burnett, R.A. (Pacific Northwest Lab., Richland, WA (United States)); Tzemos, S.; Dietz, L.A. Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 90p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004567. Source: OSTI; NTIS; INIS; GPO Dep.

Past construction and survey practices have resulted in the use of multiple local coordinate systems for measuring and reporting the horizontal position of wells and other facilities and locations on the Hanford Site. This report describes the development of a coordinate transformation process and algorithm and its application to the conversion of the horizontal coordinates of Hanford site wells from the various local coordinate systems and datums to a single standard coordinate system, the Washington Coordinate system of 1983, South Zone 1991 (WCS83S). The coordinate transformation algorithm, implemented as a computer program called CTRANS, uses standard two-dimensional translation, rotation, and scaling transformation equations and can be applied to any set of horizontal point locations. For each point to be transformed, the coefficients of the transformation equations are calculated locally, using the coordinates of the three nearest registration points (points with known locations in both coordinate systems). The report contains a discussion of efforts to verify and validate both the software and the well location data, a description of the methods used to estimate transformation and registration point accuracy, instructions for using the computer program, and a summary of the Hanford well conversion results for each local coordinate system and datum. Also included are the results of using recent U.S. Army Corps of Engineers survey data to obtain estimated measures of location errors in wells for which the local coordinate data source is undocumented, unverified, and therefore of unknown accuracy.

7455 (PNL–8958) **A summary of chemical and biological testing of proposed disposal of sediment from Richmond Harbor relative to the Deep Off-Shelf Reference Area, the Bay Farm Borrow Area, and the Alcatraz Environs Reference Area.** Mayhew, H.L. (Battelle/Marine Sciences Lab., Sequim, WA (United States)); Karle, L.M.; Gruendell, B.D.; Pinza, M.R. Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 143p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94004587. Source: OSTI; NTIS; GPO Dep.

The US Army Corps of Engineers was authorized to dredge Richmond Harbor to accomodate large, deep-draft vessels. An ecological evaluation of the Harbor sediments was performed describing the physical characteristics, toxic substances, effects on aquatic organisms,and potential for bioaccumulation of chemical contaminants. The objective of this report is to compare the sediment chemistry, acute toxicity, and bioaccumulation results of the Richmond Harbor sediments to each of the reference areas; i.e., the Deep Off-Shelf Reference Area, the Bay Farm Borrow Area, and the Alcatraz Environs Reference Area. This report will enable the US Army Corps of Engineers to determine whether disposal at a reference area is appropriate for all or part of the dredged material from Richmond Harbor. Chemical analyses were performed on 30 sediment samples; 28 of those samples were then combined to form 7 composites. The seven composites plus sediment from two additional stations received both chemical and biological evaluations.

7456 (PNL-SA–20825) **Investigation of electric fields for low-temperature treatment of soils and liquids.** Heath, W.O.; Goheen, S.C.; Miller, M.C.; Richardson, R.L. Pacific Northwest Lab., Richland, WA (United States). Feb 1992. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-920220–2: International specialty conference: in situ treatment of contaminated soil and water, Cincinnati, OH (United States), 4-6 Feb 1992). Order Number DE94004288. Source: OSTI; NTIS; INIS; GPO Dep.

Work was performed to assess the feasibility of an in situ technology for decomposing and removing hazardous organic waste compounds from soils. The technology is based on conductive soil heating and partial electrical discharges (corona) combined with soil-vapor extraction. A pilot-scale facility was developed and used to evaluate the ability to heat and dry soils using polyphase electricity applied through inserted pipes. Uniform heating (100 $\pm$ 2°C) and drying to 1.2-wt % moisture were observed. Heating and resultant in situ steam formation have been demonstrated in previous studies to be effective in removing volatile and semivolatile compounds. Corona reactors were constructed to investigate decomposition of organic compounds by oxidants produced in a point-to-liquid corona discharge in ambient air at room temperature and pressure. Point-to-liquid corona was found to be capable of destroying a wide variety of organics, including three aromatics, two polyaromatics, a pcp, a pcb, an alkane, an alkene, an amide, a complexant, a chelator, and an organic dye. Tests with trichloroethylene demonstrated a decontamination factor of 2×10^5 (equal to a destruction efficiency of 99.999995%) and nearly complete (99.7%) mineralization, with the main byproduct being aqueous chloride ions. Real-time data on the decolorization kinetics of aqueous methylene blue were obtained using in situ probe colorimetry. Reaction rates were directly proportional to the amount of unreacted dye present and the square of electrode current. Other exploratory tests were performed to investigate concepts for generating ac corona discharges in soil and the ability of those discharges to decompose adsorbed organic compounds. All findings are discussed in relation to a conceptual soil-treatment scenario that includes a description of the basic hardware requirements.

7457 (PNL-SA–22677) **The UFA method for site characterization and remediation.** Wright, J.V. (Pacific Northwest Lab., Richland, WA (United States)); Leather, J.M.; Conca, J.L. Pacific

Northwest Lab., Richland, WA (United States). Oct 1993. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931095–68: Department of Energy environmental remediation conference, Augusta, GA (United States), 24-28 Oct 1993). Order Number DE94004291. Source: OSTI; NTIS; INIS; GPO Dep.

Direct measurement was made of the unsaturated hydraulic conductivity of soils and sediments using a new experimental method. The experimental method, which uses the Unsaturated Flow Apparatus (UFA™), employs open-flow centrifugation in a new application. Centrifugation, like gravity, has the effect on a material of a whole-body force exerting equal force at all points within the sample. The equivalent gravitational force exerted throughout the sample is from one to four orders of magnitude higher than earth gravity (from 10 to 10,000 g). The result is an increase in rate of fluid flow equally at all points throughout the sample so that hydraulic steady state is obtained in most geologic materials in a few hours, even at very unsaturated conditions. This extraordinarily short time allows direct measurement of transport parameters, such as hydraulic conductivity, diffusion coefficient, and retardation factors, in any porous media over the complete range of field moisture contents. Traditional techniques and estimation methods require months to years to obtain these data, and cannot provide data for samples at low water contents. Predictive modeling, site restoration strategies, and remediation formulations can be rapidly tested with the UFA method prior to costly and time-consuming field demonstrations. From 8 to 14 measurements of hydraulic conductivity as a function of decreasing volumetric water content were made on each of approximately 50 aridisol samples from a former waste disposal area at Hanford Site in Washington State. This provided over 500 data points to define the characteristic behavior, with respect to Hanford Site vadose zone water for these soils and sediments. The large hydraulic conductivity data set provided information for mapping the subsurface recharge distribution below an area where disposal of large quantities of liquid wastes occurred during a half-century of government weapons research.

7458 (PNWD–1980-13-HEDR) **Hanford Environmental Dose Reconstruction Project, Quarterly report, September–November 1993.** Cannon, S.D.; Finch, S.M. (comps.). Pacific Northwest Lab., Richland, WA (United States). [1993]. 84p. Sponsored by Department of Health and Human Services, Washington, DC (United States). DOE Contract AC06-76RL01830. Contract 200-92-0503(CDC)18620(BNW). Order Number DE94004755. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of the Hanford Environmental Dose Reconstruction (HEDR) Project is to estimate the radiation doses that individuals and populations could have received from nuclear operations at Hanford since 1944. The project is divided into the following technical tasks. These tasks correspond to the path radionuclides followed from release to impact on humans (dose estimates); Source Terms, Environmental Transport, Environmental Monitoring Data, Demography, Food Consumption, and Agriculture, and Environmental Pathways and Dose Estimates.

7459 (UCRL-ID–110051) **Possible differences in biological availability of isotopes of plutonium: Report of a workshop.** Kercher, J.R.; Gallegos, G.M. (eds.). Lawrence Livermore National Lab., CA (United States). Sep 1993. 56p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9008144–Summ.: Workshop on possible differences in biological availability of isotopes of Plutonium, Las Vegas, NV (United States), 28-29 Aug 1990). Order Number DE94003878. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents the results of a workshop conducted on the apparent different bioavailability of isotopes ^{238}Pu and ^{239}Pu. There is a substantial body of evidence that ^{238}Pu as commonly found in the environment is more biologically available than ^{239}Pu. Studies of the Trinity Site, Nevada Test Site from nonnuclear and nuclear events, Rocky Flats, Enewetak and Bikini, and the arctic tundra support this conclusion and indicate that the bioavailability of ^{238}Pu is more than an order of magnitude greater than that of ^{239}Pu. Plant and soil studies from controlled environments and from Savannah River indicate no isotopic difference in availability of Pu to plants; whereas studies at the Trinity Site do suggest a difference. While it is possible that these observations can be explained by problems in the experimental procedure and analytical techniques, this possibility is remote given the ubiquitous nature of the observations. Studies of solubility of Pu in the stomach contents of cattle grazing at the Nevada Test Site and from fish from Bikini Atoll both found that ^{238}Pu was more soluble than ^{239}Pu. Studies of the Los Alamos effluent stream indicate that as particle size decreases, the content of ^{238}Pu relative to ^{239}Pu increases.

7460 (UCRL-JC–113059) **ARAC: A flexible real-time dose consequence assessment system.** Ellis, J.S.; Sullivan, T.J. Lawrence Livermore National Lab., CA (United States). 7 Oct 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC08-88NV10617. (CONF-9310101–2: Asia and Pacific Basin Regional Congress on radiation protection, Beijing (China), 18-22 Oct 1993). Order Number DE94003627. Source: OSTI; NTIS; INIS; GPO Dep.

Since its beginning, the Atmospheric Release Advisory Capability (ARAC), an emergency radiological dose assessment service of the US Government, has been called on to do consequence assessments for releases into the atmosphere of radionuclides and a variety of other substances. Some of the more noteworthy emergency responses have been for the Three Mile Island and Chernobyl nuclear power reactor accidents, and more recently, for a cloud of gases from a rail-car spill into the Sacramento river of the herbicide metam sodium, smoke from hundreds of burning oil wells in Kuwait, and ash clouds from the eruption of Mt. Pinatubo. The spatial scales of these responses range from local, to regional, to global, and the response periods from hours, to weeks, to months. Because of the variety of requirements of each unique assessment, ARAC has developed and maintains a flexible system of people, computer software and hardware.

7461 (USGS-WRI–92-4065) **An estimate of the roughness length and displacement height of Sonoran Desert vegetation, south-central Arizona.** Claassen, H.C. (Geological Survey, Denver, CO (United States)); Riggs, A.C. Geological Survey, Denver, CO (United States); Geological Survey, Reston, VA (United States). 1993. 20p. Sponsored by USDOE, Washington, DC (United States);Geological Survey, Reston, VA (United States). DOE Contract AI08-92NV10874 ; AI08-78ET44802. Order Number DE94003606. Source: OSTI; NTIS; GPO; U.S. Geological Survey, Books and Open-File Reports Section, Box 25425, Mail Stop 517, Federal Center, Denver, CO 80225-0425; GPO Dep.

A somewhat unconventional technique using a tethered balloon was used to estimate the roughness length for momentum (z_m) and displacement height (d) for typical Sonoran Desert vegetation. It has been suggested that measurements of the meteorological fluxes of momentum, sensible heat, and latent heat are best done at heights above ground level determined by either the roughness length (z_m) or the size and shape of vegetation. Therefore, estimates of z_m and vegetation characteristics are a desirable prerequisite to developing a flux-measurement protocol. Because the literature contains little information on z_m for Sonoran Desert vegetation, it is desirable to measure z_m and the displacement height (d) associated with Sonoran Desert vegetation.

7462 (WHC-SP–0665-8) **Quarterly environmental radiological survey summary: First quarter 1993, 100, 200, 300, and 600 Areas.** McKinney, S.M. Westinghouse Hanford Co., Richland, WA (United States). Apr 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94002654. Source: OSTI; NTIS; GPO Dep.

Routine radiological surveys to monitor conditions of outdoor sites are performed by Westinghouse Hanford Company's Health Physics Group. Areas surveyed include the road surfaces, radioactive waste storage and disposal sites (cribs, trenches, burial grounds, stabilized ponds and ditches), and unplanned release sites. (See figures 1 through 10.) This report provides a summary of the radiological surveys performed on waste sites during the First Quarter of 1993. The status of corrective action required from current and past reports are also discussed.

7463 (WSRC-MS–93-362-Rev.1) **In situ bioremediation via horizontal wells: Revision 1.** Hazen, T.C.; Looney, B.B.; Enzien,

M.; Dougherty, J.M.; Wear, J.; Fliermans, C.B.; Eddy, C.A. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-9209427--1-Rev.1: Michigan Biotechnology Institute symposium, Grand Rapids, MI (United States), 10-15 Sep 1992). Order Number DE94004033. Source: OSTI; NTIS; INIS; GPO Dep.

The test consisted of methane mixed with air into the contaminated aquifer via a horizontal well and extraction from the vadose zone via a parallel horizontal well. This configuration has the advantage of simultaneously stimulating methanotrophic activity in both the groundwater and vadose zone, and inhibiting spread of the contaminant plume. Groundwater was monitored biweekly from 13 wells for a variety of chemical and microbiological parameters. Groundwater from wells in affected areas showed increases in methanotrophs of more than 1 order of magnitude every 2 weeks for several weeks after 1% methane-in-air injection was started. Some wells had increases as much as 7 orders of magnitude. Simultaneous with the increase in methanotrophs was a decrease in water and soil gas concentrations of trichloroethylene (TCE) and tetrachloroethane (PCE). Two wells declined in TCE/PCE concentration in the water by more than 90% to below 2 ppb. All of the wells in the affected zone showed significant decreases in contaminants in less than one month. Chloride concentrations in the water were inversely correlated with TCE/PCE concentration. Four of five vadose zone piezometers declined from concentration as high as 10,000 ppm to less than 5 ppm in less than 6 weeks. The fifth cluster also declined by more than 95%. After only three months on injection, a decline in TCE/PCE in the sediment of more than 30% was also observed, with TCE/PCE being undetectable in most sediments at the end of the 14-month test. Gene probes and direct isolation from the water and sediment revealed that the right types of methanotrophs were being stimulated and that isolates could degrade TCE at a high rate.

7464 (WSRC-TR--93-393) **P-Area Acid/Caustic Basin groundwater monitoring report: Second quarter 1993.** Westinghouse Savannah River Co., Aiken, SC (United States). Sep 1993. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004441. Source: CSTI; NTIS; GPO Dep.

The six monitoring wells at the P-Area Acid/Caustic Basin are sampled quarterly as part of the Savannah River Site (SRS) Groundwater Monitoring Program and to comply with the terms of a consent decree signed May 26, 1988, by the US District Court (District of South Carolina, Aiken Division). During second quarter 1993, samples from the monitoring wells were analyzed for indicator parameters, groundwater quality parameters, parameters characterizing suitability as a drinking water supply, and other constituents. Monitoring results that exceeded the final Primary Drinking Water Standards (PDWS) or the SRS flagging criteria or turbidity standard are discussed in this report. During second quarter 1993, no constituents exceeded the final PDWS in wells at the P-Area Acid/Caustic Basin. Aluminum exceeded the SRS Flag 2 criterion in wells PAC 1, 3, 4, 5, and 6. Iron and manganese each exceeded the Flag 2 criterion in wells PAC 2, 3, 5, and 6. Lead was elevated above its Flag 2 criterion in well PAC 5, and radium-228 was above its proposed DWS (Flag 2) in wells PAC 3 and 6. Radium-228 results that exceeded nonvolatile beta activities were reported in these and other wells.

7465 (WSRC-TR--93-394) **K-Area/Caustic Basin Groundwater Monitoring Report: Second quarter 1993.** Thompson, C.Y. Westinghouse Savannah River Co., Aiken, SC (United States). Sep 1993. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004030. Source: OSTI; NTIS; GPO Dep.

During second quarter 1993, samples from the KAC monitoring wells at the K-Area Acid/Caustic Basin were collected and analyzed for indicator parameters, groundwater quality parameters, parameters indicating suitability as drinking water, and other constituents. Monitoring results that exceeded the final Primary Drinking Water Standards (PDWS) or the Savannah River Site (SRS) flagging criteria or turbidity standard during the quarter are discussed in this report. No analytes exceeded the final PDWS during second quarter 1993. Aluminum exceeded its Flag 2 criterion in wells KAC 6, 7, and 9. Iron exceeded the Flag 2 criterion in wells KAC 6 and 7, and specific conductance exceeded the Flag 2 criterion in well KAC 9. No samples exceeded the SRS turbidity standard.

7466 (WSRC-TR--93-398) **K-Area and Par Pond Sewage Sludge Application Sites groundwater monitoring report: Second quarter 1993.** Westinghouse Savannah River Co., Aiken, SC (United States). Oct 1993. 56p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004444. Source: OSTI; NTIS; GPO Dep.

During second quarter 1993, samples from the three monitoring wells at the K-Area site (KSS series) and the three monitoring wells at the Par Pond site (PSS series) were analyzed for constituents required by South Carolina Department of Health and Environmental Control Construction Permit 13,173 and for other constituents as part of the Savannah River Site (SRS) Groundwater Monitoring Program. This report describes monitoring results that exceeded the final Primary Drinking Water Standards (PDWS) or the SRS flagging criteria. During second quarter 1993, no constituents exceeded the final PDWS or any other flagging criteria at the K-Area and Par Pond Sewage Sludge Application Sites. During first quarter 1993, aluminum and iron exceeded the SRS Flag 2 criteria in one or more of the KSS and the PSS wells. These constituents were not analyzed second quarter 1993. In the KSS well series, the field measurement for alkalinity ranged as high as 35 mg/L in well KSS 1D. Alkalinity measurements were zero in the PSS wells, except for a single measurement of 1 mg/L in well PSS 1D. Historical and current water-level elevations at the K-Area Sewage Sludge Application Site indicate that the groundwater flow direction is south to southwest (SRS grid coordinates). The groundwater flow direction at the Par Pond Sewage Sludge Application Site could not be determined second quarter 1993.

5403 Environmental Sciences, Aquatic

Refer also to citation(s) 6108, 6241, 6253, 6290, 6782, 6790, 7301, 7388, 7427, 7434, 7437, 7438, 7455, 7458, 7482, 7907, 7920

7467 (DOE/ER/61054--3) **Simulation of the carbon cycle in the oceans: Annual report, Third year, September 15, 1992--September 14, 1993.** Siegenthaler, U. Bern Univ. (Switzerland). 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER61054. Order Number DE94000780. Source: OSTI; NTIS; GPO Dep.

In this report, the authors conclude that the average oceanic uptake of anthropogenic CO_2, as determined from four different ocean models and normalized to the observed mean penetration depth of bomb^{-1} ^{4}C (analogue to anthropogenic CO_2), is 2.0 $\pm$ 0.5 GtC/yr (decade 1980--1989). This oceanic uptake plus the year-to-year growth of the atmospheric CO_2 content together are less by 1.8 $\pm$ 1.2 GtC/yr than the estimated anthropogenic CO_2 emissions from fossil fuels and land use.

7468 (DOE/ER/61540--1) **Global survey of carbon dioxide in the ocean: Progress report, January 1, 1993--December 31, 1993.** Sabine, C.; Key, R.M.; Sarmiento, J.L. Princeton Univ., NJ (United States). Sep 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-93ER61540. Order Number DE94001787. Source: OSTI; NTIS; GPO Dep.

This proposal was submitted in response to the DOE call for proposals to participate in obtaining carbon system measurements as part of the World Ocean Circulation Experiment/Hydrographic Program (WOCE/HP). The authors' interest in participating in this global survey stemmed from two major research directions in which our their has been actively involved. The first is the DOE supported ocean carbon cycle model development program. The models developed as part of this program clearly demonstrate the importance of ocean carbon measurements in constraining the oceanic sink of anthropogenic carbon dioxide. The creation of a CO_2 measurement program at Princeton allowed the unique ability for a close interaction between the modellers and the people actually making the measurements. This interaction strengthens both programs.

7469 (DOE/EW/50625–T7) **[Environmental Hazards Assessment Program annual report, June 1992–June 1993]: Use of diatom distributions to monitor environmental health.** Levine, R.H. (Wesleyan Univ., Middletown, CT (United States)). Medical Univ. of South Carolina, Charleston, SC (United States). [1993]. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE94004506. Source: OSTI; NTIS; INIS; GPO Dep.

A variety of approaches has been used in the past to assess the environmental impact of anthropogenic contaminants. One reliable index for aquatic environments is the analysis of diatom species distribution; the focus in this case being on the Savannah River. The completed objectives of this study were: (A) the development and use of procedures for measuring diatom distribution in the water column and (B) the development and evaluation of sediment sampling methods for retrospective analysis.

7470 (DOE/EW/53023–T3) **Hazardous materials in aquatic environments of the Mississippi River Basin: Quarterly project status report, July 1, 1993–September 30, 1993.** Tulane Univ., New Orleans, LA (United States). [1993]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-93EW53023. Order Number DE94002242. Source: OSTI; NTIS; GPO Dep.

This document is a brief progress report from each of the research and education projects that are currently funded through the ERWM contract. During third quarter 1993, approval was given by DOE for purchase of equipment. Equipment purchases were initiated and much of the equipment has been received and installed. The committees in charge of coordination of sampling and analyses associated with the collaborative research groups continued to meet and address these issues. Sampling has been done in the lower part of Devil's Swamp and in the Devil's Swamp Lake area. In addition, extensive sampling has been done in Bayou Trepagnier and in Bayou St. John. During this period, Tulane and Xavier Universities continued working closely with Oak Ridge National Laboratories (ORNL). The ORNL 1993 summer student internship program was completed. Plans were made for expanding the program to support 8 students next summer. Leonard Price, a Xavier University Chemistry professor and John Walz, a Tulane University Engineering professor each spent 5 weeks at ORNL. During this time these faculty worked with ORNL researchers exploring mutual interests and discussing possible future collaborations. In September, Drs. Carl Gehrs, Lee Shugart and Marshall Adams of ORNL, visited the Tulane and Xavier campuses. They presented two seminars and met with several of the investigators being supported by the ERWM contract. Tulane/Xavier project administrators participated in the Office of Technology Development's "New Technologies and Program Exhibition" in the Rayburn House Office Building on September 23 and in the Hart Senate Office Building on September 27.

7471 (DOE/OR/00033–T566) **Growth, life history, and species interactions of bluegill sunfish (Lepomis macrochirus) under heavy predation.** Belk, M.C. (Georgia Univ., Athens, GA (United States)). Oak Ridge Associated Universities, Inc., TN (United States); Georgia Univ., Athens, GA (United States). 1992. 128p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033 ; AC09-76SR00819. Order Number DE94001409. Source: OSTI; NTIS; GPO Dep.

The purpose of this study was, first, to compare growth and life history characteristics of an unfished population of bluegill sunfish (Lepomis macrochirus) in the presence of an abundant predator population to characteristic exhibited by bluegills in typical southeastern US reservoirs where the abundance of predators is reduced, but fishing is increased. The second objective was to determine if differences observed between populations were determined genetically or environmentally.

7472 (DOE/OR/00033–T568) **Effect of snails (Elimia clavaeformis) on phosphorus cycling in stream periphyton and leaf detritus communities.** Jay, E.A. (North Carolina Univ., Chapel Hill, NC (United States)). Oak Ridge Associated Universities, Inc., TN (United States); North Carolina Univ., Chapel Hill, NC (United States). 1993. 79p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE94001411. Source: OSTI; NTIS; GPO Dep.

In this study, the author examined the effect of grazing on phosphorus cycling in stream periphyton and leaf detritus communities using the snail Elimia clavaeformis. Phosphorus cycling fluxes and turnover rates were measured in a laboratory and in a natural stream, respectively, using radioactive tracer techniques.

7473 (ENEA-RT-AMB–92-08) **Finite element model for prediction of circulation in Gulf of La Spezia (Italy): Tide, wind and seiche effects analysis.** Baldi, A. (ENEA, La Spezia (Italy). Centro Ricerche Energia Ambiente Santa Teresa); Marri, P. No corporate text available. Mar 1993. 29p. (In Italian). (RT/AMB–92-08). Order Number DE94727309. Source: OSTI; NTIS (US Sales Only).

This report describes the use of a finite element model for the prediction of circulation in the Gulf of La Spezia. This model is able to simulate the depth average circulation within small scale embayments characterized by irregular boundaries and bottom topography. The forcing terms, here considered are the tide, the wind and a seiche. The simulations describe the different roles of these forcing terms and the results have demonstrated that a seiche with a period of 70 minutes and an amplitude of 3 cm can be an important forcing term for the circulation in the Gulf of La Spezia and for the flushing time of the harbour waters. This seiche can explain the current velocity values measured in the Gulf and determines the flushing time and the water quality of the harbour.

7474 (INIS-GB–521) **Fisheries and the marine environment: policy support and research 1991-92: Report of the director.** Ministry of Agriculture, Fisheries and Food, Lowestoft (United Kingdom). Directorate of Fisheries Research. 1993. 40p. Order Number DE94610484. Source: OSTI; NTIS (US Sales Only); INIS.

This Directorate of Fisheries Report for 1991-2 reviews the work of the Fish Stock Management Division and the Aquatic Environment Protection Division in the fields of control and monitoring of non-radioactive and radioactive waste and of fish and shellfish disease monitoring. (UK).

7475 (INIS-mf–13734, pp. 317-323) **Investigations of the connection between seismicity and ^{222R}n-CO_2 content in spring waters at the Vogtland area (Germany): first results.** Heinicke, J. (Saxon Academy of Sciences, Leipzig (Germany). Research Group Freiberg/Bad Brambach); Koch, U.; Martinelli, G. Ceskoslovenska Akademie Ved, Prague (Czech Republic). Geofyzikalni Ustav. 1993. (CONF-9209428–: 23. general assembly of the European Seismological Commission, Prague (Czech Republic), 7-12 Sep 1992). In *Activity report 1990-1992 and proceedings. Volume II.* 213p. Order Number DE94610481. Source: OSTI; NTIS (US Sales Only); INIS.

The measurements were carried out at the 'Radonquelle' spring water of Bad Brambach (^{222}Rn activity: 25 kBq.l^{-1}). The results of radon measurements over a period of three years show some significant anomalies in radon activity before, during, and after microseismic events in the region. The measuring interval for calculating the daily average value was < 1 hour. The results also show a good correlation between the CO_2 and radon parameters in an interval measured during a seismically quiet period. (Z.S.) 2 tabs., 7 figs., 18 refs.

7476 (IVL-B–1119) **Life cycle assessments and eutrophication: A concept for calculation of the potential effects of nitrogen and phosphorous.** Samuelsson, M.O. Swedish Environmental Research Inst., Stockholm (Sweden). Oct 1993. 15p. Order Number DE94730429. Source: OSTI; NTIS.

The aim with this report was to make an attempt to calculate the potential effect, on aquatic ecosystems, by nitrogen, phosphorus and organic material to be used in life cycle assessment. In addition, to identify lack of knowledge that has to be study for improving the LCA analysis. It is suggested in this report that the amount of nitrogen and phosphorus transported to the aquatic environment are recalculated to the amount organic carbon that nitrogen and phosphorus can mediate. The produced organic carbon is then used to calculate the potential oxygen consumption by the material. This is made by using the reversed photosynthesis

including oxygen consumption by nitrification. By the use of the relationship it is revealed that 1 mol organic carbon consumes 1.3 mol oxygen. The value of COD by the organic material emitted to the aquatic ecosystem can then be added to the calculated oxygen consumption. Examples are given in the report on non-site specific and site specific calculations. 17 refs, 4 figs, 1 tab

7477 (LA-UR–93-1963) **Geomorphology of plutonium in the Northern Rio Grande.** Graf, W.L. (Arizona Univ., Tempe, AZ (United States). Dept., of Geography). Los Alamos National Lab., NM (United States). Mar 1993. 389p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003576. Source: OSTI; NTIS; INIS; GPO Dep.

Nearly all of the plutonium in the natural environment of the Northern Rio Grande is associated with soils and sediment, and river processes account for most of the mobility of these materials. A composite regional budget for plutonium based on multi-decadal averages for sediment and plutonium movement shows that 90 percent of the plutonium moving into the system is from atmospheric fallout. The remaining 10 percent is from releases at Los Alamos. Annual variation in plutonium flux and storage exceeds 100 percent. The contribution to the plutonium budget from Los Alamos is associated with relatively coarse sediment which often behaves as bedload in the Rio Grande. Infusion of these materials into the main stream were largest in 1951, 1952, 1957, and 1968. Because of the schedule of delivery of plutonium to Los Alamos for experimentation and weapons manufacturing, the latter two years are probably the most important. Although the Los Alamos contribution to the entire plutonium budget was relatively small, in these four critical years it constituted 71–86 percent of the plutonium in bedload immediately downstream from Otowi.

7478 (LUNBDS-NBKE–92-5002) **Loading of organo chlorines to a water body; Fate within the baltic sea.** Jaernmark, C. Lund Univ. (Sweden). Dept. of Ecology. 1992. 31p. Order Number DE94730411. Source: OSTI; NTIS.

The aim of this paper is to review mechanisms and interactions that determines the transport and fate of organic air pollutants with special focus on the Baltic ecosystem. Following areas are treated: occurrence forms and transportation of the pollutants in the atmosphere; exchange between the atmosphere and the aquatic environment; movement within the aquatic ecosystem; the sediments role as potential sink; and, how these pollutants are taken up by aquatic organisms. 84 refs, 5 figs, 1 tab

7479 (NEI-NO–383, pp. 154-167) **Climatic effects on fresh water: Nutrient loading, eutrophication and acidification.** Hessen, D.O. (Norwegian Inst. for Water Research, Oslo (Norway)); Wright, R.F. Norsk Inst. for Naturforskning, Trondheim (Norway); Direktoratet for Naturforvaltning, Trondheim (Norway). Feb 1993. (CONF-9011339–: Impact of climatic change on natural ecosystems, with emphasis on boreal and arctic/alpine areas, Trondheim (Norway), 27-29 Nov 1990). In *Impacts of climatic change on natural ecosystems with emphasis on boreal and arctic/alpine areas.* 185p. Order Number DE94730364. Source: OSTI; NTIS.

Climatic change will affect the aquatic environment both directly and indirectly through effects within the catchment area. This in turn will affect water quality for the downstream ecosystems; streams, lakes and the coastal marine environment. We have evaluated the potential effects on boreal aquatic ecosystems in Norway based on a future climatic scenario entailing a 2-4°C increase in temperature and a 5-15% increase in precipitation. A temperature increase can lead to increased mineralisation of organic matter stored in soils. This will release nutrients such as nitrogen and phosphorus, and may affect the trophic status of lakes. The expected changes include increased runoff, increased erosion and mineralisation and thus increased phosphorus loading in winter, summer being characterised by lower loadings but an extended growing season. Assessments based on empirical models suggest no major changes or possibly a slightly improved eutrophic status in large, deep, oligo- to mesotrophic lakes. An increase in total annual phosphorus loading combined with an extended growing season may cause adverse effects in more productive lakes, in particular shallow lakes with periodic oxygen depletion. In addition, phosphorus loading to coastal waters may increase owing to increased erosion in low-lying agricultural areas. A future climate with mild winters can result in major changes in seasonal patterns of freshwater quality. The acid pulse, typical of the spring thaw today, can be replaced by frequent acid pulses during the winter or by chronically acid water all winter. 21 refs., 13 figs., 1 tab.

7480 (NUTEK–91-173) **Stensund aquaculture - ecological technique for waste water treatment.** Guterstam, B. (Stensunds Folkhoegskola, Trosa (Sweden)). Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). Sep 1992. 27p. (In Swedish). Order Number DE94730441. Source: OSTI; NTIS.

The aim of this project is to demonstrate a technique for recycling of plant nutrients and extraction of heat from waste waster. The method use constructed food webs for detoxification and decomposition of the wastes, before inclusion in new biomass in plants and animals. The processes takes place in a specially designed greenhouse, for whole year operation in a Nordic climate.

7481 (SAND–93-2616C) **A comparative evaluation of SAR and SLAR.** Mastin, G.A. (Sandia National Labs., Albuquerque, NM (United States)); Manson, J.J.; Bradley, J.D.; Axline, R.M.; Hover, G.L. Sandia National Labs., Albuquerque, NM (United States). [1993]. 11p. Sponsored by Coast Guard, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940123–1: 2. thematic conference on remote sensing for marine and coastal environments, New Orleans, LA (United States), 31 Jan - 2 feb 1994). Order Number DE94002922. Source: OSTI; NTIS; GPO Dep.

Synthetic aperture radar (SAR) was evaluated as a potential technological improvement over the Coast Guard's existing side-looking airborne radar (SLAR) for oil-spill surveillance applications. The US Coast Guard Research and Development Center (R&D Center), Environmental Branch, sponsored a joint experiment including the US Coast Guard, Sandia National Laboratories, and the Naval Oceanographic and Atmospheric Administration (NOAA), Hazardous Materials Division. Radar imaging missions were flown on six days over the coastal waters off Santa Barbara, CA, where there are constant natural seeps of oil. Both the Coast Guard SLAR and the Sandia National Laboratories SAR were employed to acquire simultaneous images of oil slicks and other natural sea surface features that impact oil-spill interpretation. Surface truth and other environmental data were also recorded during the experiment. The experiment data were processed at Sandia National Laboratories and delivered to the R&D Center on a computer workstation for analysis by experiment participants. Issues such as optimal spatial resolution, single-look vs. multi-look SAR imaging, and the utility of SAR for oil-spill analysis were addressed. Finally, conceptual design requirements for a possible future Coast Guard SAR were outlined and evaluated.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5501 Behavioral Biology

7482 (DOE/BP/35885–3) **Juvenile passage program: A plan for estimating smolt travel time and survival in the Snake and Columbia Rivers.** Skalski, J.R. (Univ. of Washington, Seattle, WA (United States). Center for Quantitative Science); Giorgi, A. Washington Univ., Seattle, WA (United States). Center for Quantitative Science; Chapman (Don) Consultants, Inc., Redmond, WA (United States). Oct 1993. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract BI79-87BP35885 ; AI79-91BP16570. Order Number DE94005630. Source: OSTI; NTIS; GPO Dep.

A plan for developing a program to evaluate juvenile salmon passage is presented that encompasses the Snake (Lower Granite to McNary Dams), Mid-Columbia (Wells to McNary Dams), and Lower Columbia (McNary to Bonneville Dams) segments of the Snake/Columbia River system. This plan focuses on the use of PIT-tag technology to routinely estimate travel times and reach survival of outmigrating yearling and subyearling Chinook, sockeye, and steelhead during spring and summer months. The proposed program outlines tagging studies that could be implemented in (a)

1992, (b) near term (1993–94), and (c) long term (1995 to the next decade). The evolution of this program over time parallels plans to establish additional PIT-tag detector and slide-gate systems at Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams. The eventual ability to concurrently estimate travel time and survival of release groups will permit evaluation of travel time-survival-flow relationships and identify possible mortality "hot spots" for remediation.

5502 Biochemistry

Refer also to citation(s) 7496, 7752

7483 (CONF-9309269–1) **The catalytic inactivation of cellulase enzyme components by palladium complexes.** Woodward, J.; Gooch, M.G.; Shultz, M.D. Oak Ridge National Lab., TN (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400 ; AC02-83CH10093. From Department of Energy/National Renewable Energy Laboratory (DOE/NREL) ethanol project review meeting; Lakewood, CO (United States); 27-29 Sep 1993. Order Number DE94001136. Source: OSTI; NTIS; GPO Dep.

It has been discovered that sodium hexachloropalladate is a strong inhibitor of cellobiohydrolase I (CBH I) from Trichoderma reesei having an I_{50} of <50 μM with p-nitrophenylcellobioside (PNPC) as the substrate. Similar complexes of the metals platinum, osmium, iridium, and rhodium have little effect on CBH I. Other cellulase activities (Avicelase, β-glucanase) are also inhibited by the palladium complex, suggesting that inhibition of two major types of catalytic activity in cellulase are affected. Preliminary data on the kinetics of inhibition of CBH I by sodium hexachloropalladate indicate that the inhibition is reversible and, possibly, uncompetitive. It is anticipated that sodium hexachloropalladate and other palladium complexes will be useful for determining the effect of the binding of catalytically inactivated CBH I and other cellulase components on the structure of cellulose fibers.

7484 (LBL–34897) **The application of psoralens to the study of DNA structure, function and dynamics.** Spielmann, P.H. (Univ. of California, Berkeley, CA (United States). Dept. of Chemistry). Lawrence Berkeley Lab., CA (United States). Apr 1991. 202p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94005204. Source: OSTI; NTIS; GPO Dep.

A series of six nitroxide spin-labeled psoralens were designed, synthesized and tested as probes for DNA dynamics. The synthesis of these spin-labeled psoralen derivatives and their photoreactivity with double-stranded DNA fragments is described. The spin labels (nitroxides) were demonstrated to survive the uv irradiation required to bind the probe to the target DNA. EPR spectra of the photobound spin-labels indicate that they do not wobble with respect to the DNA on the time-scales investigated. The author has used psoralen modified DNA as a model for the study of DNA repair enzyme systems in human cell free extracts. He has shown that damage-induced DNA synthesis is associated with removal of psoralen adducts and therefore is "repair synthesis" and not an aberrant DNA synthesis reaction potentiated by deformation of the DNA by adducts. He has found that all DNA synthesis induced by psoralen monoadducts is the consequence of removal of these adducts. By the same approach he has obtained evidence that this in vitro system is capable of removing psoralen cross-links as well. Reported here are synthetic methods that make use of high intensity lasers coupled with HPLC purification to make homogeneous and very pure micromole quantities of furan-side monoadducted, cross-linked, and pyrone-side monoadducted DNA oligonucleotide. These molecules are currently being studied by NMR and X-ray crystallography. The application of the site-specifically psoralen modified oligonucleotide synthesized by these methods to the construction of substrates for the investigation of DNA repair is also discussed.

7485 (LBL–34903) **Structures and related properties of helical, disulfide-stabilized peptides.** Pagel, M.D. (Univ. of California, Berkeley, CA (United States). Dept. of Chemistry). Lawrence Berkeley Lab., CA (United States). Nov 1993. 206p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94005210. Source: OSTI; NTIS; GPO Dep.

The three dimensional structure of several peptides were determined by NMR spectroscopy and distance geometry calculations. Each peptide formed a predictable, rigid structure, consisting of an α-helix, a "scaffold" region which packed along one face of the helix, and two disulfide bridges which covalently connect the helix and scaffold regions. The peptide Apa-M5 was designed to constrain the M5 peptide from MLCK in a helical geometry using the apamin disulfide scaffold. This scaffold constrains the N- terminal end of the helix with two disulfide bridges and a reverse turn. Like the M5 peptide, Apa-M5 was found to bind calmodulin in a Ca^{2+}-dependent 1:1 stoichiometry. However, the dissociation constant of the (Apa-M5)-calmodulin complex, 107 nM, was 100-fold higher than the dissociation constant of the M5-calmodulin complex. This difference was due to a putative steric overlap between the Apa-M5 scaffold and calmodulin. The peptide Apa-Cro was designed to replace the large structural protein matrix of λ Cro with the apamin disulfide scaffold. However, Apa-Cro did not bind the consensus DNA operator half-site of λ Cro, probably due to a steric overlap between the Apa-Cro disulfide framework and the DNA. The amino acid sequence of the scaffold-disulfide bridge arrangement of the peptide Max was derived from the core sequence of scyllatoxin, which contains an α-helix constrained at the C-terminal end by two disulfide bridges and a two-stranded βsheet scaffold. Max was shown to fold with >84% yield to form a predictable, stable structure that is similar to scyllatoxin. The folding and stability properties of Max make this scaffold and disulfide bridge arrangement an ideal candidate for the development of hybrid sequence peptides. The dynamics of a fraying C-terminal end of the helix of the peptide Apa-AlaN was determined by analysis of ^{15}N NMR relaxation properties.

7486 (UCRL-JC–113838) **Accelerator mass spectrometry in biomedical research.** Vogel, J.S.; Turteltaub, K.W. Lawrence Livermore National Lab., CA (United States). 20 Oct 1993. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-930960–4: 6. international conference on accelerator mass spectrometry, Canberra (Australia), 17 Sep - 1 oct 1993). Order Number DE94004336. Source: OSTI; NTIS; INIS; GPO Dep.

Biological effects occur in natural systems at chemical concentrations of parts per billion ($1:10^9$) or less. Affected biomolecules may be separable in only milligram or microgram quantities. Quantification at attomole sensitivity is needed to study these interactions. AMS measures isotope concentrations to parts per 10^{13}--^{15} on milligram-sized samples and is ideal for quantifying long-lived radioisotopic labels that are commonly used to trace biochemical pathways in natural systems. ^{14}C-AMS has now been coupled to a variety of organic separation and definition technologies. The primary research investigates pharmacokinetics and genotoxicities of toxins and drugs at very low doses. Human subject research using AMS includes nutrition, toxicity and elemental balance studies. ^{3}H, ^{41}Ca and ^{26}Al are also traced by AMS for fundamental biochemical kinetic research. Expansion of biomedical AMS awaits further development of biochemical and accelerator technologies designed specifically for these applications.

7487 (UCRL-JC–115381) **^{14}C-AMS quantification of biomolecular interactions using microbore and plate separations.** Creek, M.R.; Frantz, C.E.; Fultz, E.; Haack, K.; Redwine, K.; Shen, N.; Turteltaub, K.W.; Vogel, J.S. Lawrence Livermore National Lab., CA (United States). 20 Oct 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-930960–5: 6. international conference on accelerator mass spectrometry, Canberra (Australia), 17 Sep - 1 oct 1993). Order Number DE94004335. Source: OSTI; NTIS; GPO Dep.

AMS sensitivity arises from the direct counting of radioisotopes without interference from molecular isobars. No chemical or physical information other than a bulk isotope ratio is available from the usual AMS instrument. Chemical or biological significance of the isotope ratio depends on the definition of the sample prior to conversion to material used in the ion source. The authors use AMS to

quantify biochemical interactions between labeled xenobiotics and their potential targets of toxicity. These potential target molecules are separated and defined by various types of plate and microbore separations, including thin layer chromatography (TLC), high performance liquid chromatography (HPLC) and gel electrophoresis (GE) in quantifying the binding of ^{14}C-labeled compounds to specific DNA and protein fragments. They discuss their methods of using these microbore and plate separations of biomolecules while controlling contamination from ^{14}C in laboratory equipment and give examples.

5503 Cytology

Refer also to citation(s) 7487

5504 Genetics

Refer also to citation(s) 6390

7488 (DOE/ER/61256–T2) **Role of X-ray-induced transcripts in adaptive responses following X-rays: Progress report – year 2.** Boothman, D.A. Michigan Univ., Ann Arbor, MI (United States). [1993]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER61256. Order Number DE94005412. Source: OSTI; NTIS; GPO Dep.

The overall goal of this proposal is to clone low dose X-ray-induced genes via molecular biology cloning techniques. From previous data, certain human cells can clearly carry out adaptive survival responses (ASRs) following ionizing radiation. Research goals are to better understand how some human cells can establish ASRs, and why other cells fail to do so. The author has been successful at identifying several genes whose expressions are altered during the establishment of, and actual processes occurring in, the adaptive response of U1-Mel cells. He will, in the next year or so, investigate the kinetics of expression of these genes, and whether or not other environmental stresses affect the expressions of these genes via Northern blot analyses. Finally, he will begin to investigate the function(s) of these genes within the cell, either under normal conditions of growth or following X-irradiation, using antisense expression technologies. Antisense RNA analyses and DNA repair endpoints (i.e., survival recovery, alkaline/neutral filter elutions, and PFGE) will be combined to examine the effects of specific gene "knock out" experiments on ASRs in those human cells which demonstrate this response. The authors is constructing mammalian expression vectors containing cyclin A, cyclin B, p53, or xip5, and xip12 (when full-length cDNAs are available) in the "sense" orientation to overexpress these genes in human cells which did not demonstrate ASRs, such as HTB-152 or a variety of other human fibroblasts. Since many of the xips identified by 2-D gel electrophoresis were cell cycle regulated, the factors turning them on or off within a normal cell cycle may be clearly related to the events occurring in human cells following a genetic insult.

7489 (LA-UR–93-4107) **Genetic algorithms for minimal source reconstructions.** Lewis, P.S.; Mosher, J.C. Los Alamos National Lab., NM (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9311135–1: Institute of Electrical and Electronic Engineers (IEEE) asilomar conference on signals, systems, and computers, Pacific Grove, CA (United States), 1-3 Nov 1993). Order Number DE94003940. Source: OSTI; NTIS; GPO Dep.

Under-determined linear inverse problems arise in applications in which signals must be estimated from insufficient data. In these problems the number of potentially active sources is greater than the number of observations. In many situations, it is desirable to find a minimal source solution. This can be accomplished by minimizing a cost function that accounts from both the compatibility of the solution with the observations and for its "sparseness". Minimizing functions of this form can be a difficult optimization problem. Genetic algorithms are a relatively new and robust approach to the solution of difficult optimization problems, providing a global framework that is not dependent on local continuity or on explicit starting values. In this paper, the authors describe the use of genetic algorithms to find minimal source solutions, using as an example a simulation inspired by the reconstruction of neural currents in the human brain from magnetoencephalographic (MEG) measurements.

7490 (LA-UR–93-4210) **Collaborative computing for gene mapping.** Gatewood, J.M. Los Alamos National Lab., NM (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9308192–1: Real time applications of high performance computation for biological imaging, Urbana, IL (United States), Aug 1993). Order Number DE94003932. Source: OSTI; NTIS; GPO Dep.

The authors are investigating mechanisms for utilizing advances in high performance computing and alignment algorithm development which will allow the analysis of newly acquired sequence data in real time and eliminate the global alignments problems associated with existing datasets. The presence of repetitive DNA sequences in the human genome complicates the process of homology comparisons. Three approaches have been used to address this problem. Two of the approaches involve elimination of the repetitive elements either by removing the repetitive element from the query or scoring words due to the repetitive elements poorly or not at all during the alignment process. The approach involves identification of the repetitive element in the query by comparison to a known repeat set prior to comparison to the large database. Any homologies returned which are contained within a previously identified repeat are ignored unless the homology exceeds set quality parameters. The homologies which extend outside the bounds of the repetitive element are reported. Using this approach the repeat is not eliminated from larger homologous units which may exist, and is returned as part of the overall homology result. The method the authors utilize in the laboratory for gene mapping is fluorescent in situ hybridization (FISH). This approach involves labelling a gene segment with a fluorescent molecule and then mixing the labeled gene segment (probe) with chromosomes.

5505 Metabolism

Refer also to citation(s) 6457, 7486

5506 Medicine

Refer also to citation(s) 7202, 7509

7491 (BNL–49587) **A storage ring based inverse Compton scattering angiography source?.** Blum, E.B. Brookhaven National Lab., Upton, NY (United States). Sep 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE94003085. Source: OSTI; NTIS; GPO Dep.

Producing the 33.17 keV photons required for coronary angiography with synchrotron radiation requires a combination of a high energy storage ring with an extremely high field wiggler. Such a source may be too big and expensive to be installed in even the largest medical center. Something other than synchrotron radiation may be needed for a practical source. Inverse Compton scattering has been used in the LEGS experiment at NSLS and elsewhere to produce high energy photons. In this process, a head on collision between a low energy photon and a high energy electron transfers energy to the photon which is then emitted in approximately the direction of the incoming electron. For a given electron energy, more higher energy photons can be produced by this method than by synchrotron radiation. This suggests that inverse Compton scattering can possibly be used for a low cost angiography source. The prospects for such a source will be examined in this paper. Unfortunately, the results will show that although it is easy to obtain the required photon energy, an extremely complicated source will be needed to produce the required number of photons.

7492 (DOE/EW/50625–T3) **[Environmental Hazards Assessment Program annual report, June 1992–June 1993]: Results of the environmental health activities and needs assessment of the South Carolina statewide family practice system for the Environmental Hazards Assessment Program: EHAP Volume 1, No. 1.** Musham, C.; Hainer, B. Medical Univ. of South Carolina, Charleston, SC (United States). 1 May 1993. 24p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract FG01-92EW50625. Order Number DE94004510. Source: OSTI; NTIS; INIS; GPO Dep.

An activities and needs assessment was conducted to determine what each of the seven family practice residency programs in South Carolina is providing in environmental health education. In addition, this study was designed to determine: what are the barriers to greater emphasis on environmental health in family practice residency programs and, what the basic environmental health educational goals for family practice residency programs should be.

7493 (GSI–93-23) **Experimental radiotherapy unit to be established at GSI in Darmstadt.** Kraft, G. (comp.); Gademann, G. (comp.). Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany); Heidelberg Univ., Mannheim (Germany). Inst. fuer Klinische Radiologie; Deutsches Krebsforschungszentrum, Heidelberg (Germany). May 1993. 94p. (In German). Order Number DE94734094. Source: OSTI; NTIS (US Sales Only); INIS.

The Radiologische Universitaetsklinik, Heidelberg, the Gesellschaft fuer Schwerionenforschung, GSI, Darmstadt, and the Deutsches Krebsforschungszentrum (DKFZ), Heidelberg, have filed an application for a joint project intended to study the feasibility and methodology of an enhancement of radiotherapy by way of application of heavy ions and novel irradiation techniques. The experimental radiotherapy unit is to be installed at the heavy ion synchrotron of GSI. It is planned to have about 70 patients a year taking part in the clinical study extending over a period of five years. The results obtained shall be analysed to answer the following questions: - Is the technique developed suitable for clinical routine? - Are the improved dose distributions obtained with the charged particles more effective for local tumor healing than the radiation applied for conventional radiotherapy? - Can an additional clinical effect be attributed to the high-LET properties of the heavy charged particles? - Do the results indicate novel applications of the high-precision radiotherapy using heavy ions? The project is also intended to yield baseline data for defining the concept and technical conditions of heavy-ion radiotherapy as a clinical routine method and therefore also encompasses a design study for a heavy-ion accelerator exclusively for clinical applications. (orig./MG)

7494 (INIS-RU–346) **Fast neutrons in treatment of neoplasms: Proceedings of All-union conference.** Zyryanov, B.N. (ed.). Akademiya Meditsinskikh Nauk SSSR, Tomsk (Russian Federation). Onkologicheskij Nauchnyj Tsentr. 1992. 138p. (In Russian). (CONF-9206423–: Fast neutrons in treatment of neoplasms, Tomsk (Russian Federation), 16-17 Jun 1992). Order Number DE94610668. Source: OSTI; NTIS (US Sales Only); INIS.

Physical, radiobiological, clinical aspects of neutron capture therapy (NCT) were considered. Problems of planning and optimization of NCT courses were discussed. Data of nature of radiation pathomorphosis, radiation injuries of healthy tissues were presented. Problems of acute radiation sickness caused by neutron radiation were regarded.

7495 (LBL–34512-Summ.) **An optimal constrained linear inverse method for magnetic source imaging.** Hughett, P. (Lawrence Berkeley Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9311114–4: Institute of Electrical and Electronic Engineers (IEEE) medical imaging conference, San Francisco, CA (United States), 4-6 Nov 1993). Order Number DE94004014. Source: OSTI; NTIS; GPO Dep.

The optimal constrained linear inverse method (OCLIM) is a new algorithm for magnetic source imaging that approximates an unknown continuous current distribution as a weighted sum of current sources in fixed positions, uses prior information about the expected source power density and measurement noise, and can be efficiently computed. It achieves the minimum possible mean square reconstruction error for any linear estimator and provides statistical confidence limits on the reconstructed source amplitudes. The minimum-norm least squares and weighted pseudoinverse methods are included as special cases. However, OCLIM can produce reconstruction artifacts if the true current distribution is inconsistent with the assumed priors.

5507 Microbiology

Refer also to citation(s) 6017, 6260, 6390, 6457, 6897

7496 (DOE/ER/60848–3) **The use of molecular techniques to evaluate the survival of a microorganism that was injected into an aquifer.** Thiem, S.M. (Michigan State Univ., East Lansing, MI (United States)); Tiedje, J.M.; Krumme, M.L.; Smith, R.L. Michigan State Univ., East Lansing, MI (United States). 1993. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER60848. Order Number DE94001645. Source: OSTI; NTIS; GPO Dep.

An anonymous polymerase chain reaction (PCR) primer set and an internal probe were developed that are specific for Pseudomonas sp. strain B13, a 3-chlorobenzoate-metabolizing strain. Using this primer set and probe, we were able to detect Pseudomonas sp. strain B13 DNA sequences in DNA extracted from aquifer samples fourteen and a half months after Pseudomonas sp. strain B13 had been injected into a sand and gravel aquifer on Cape Cod. This primer-set and probe was also used to analyze isolates from 3-chlorobenzoate enrichments of the aquifer samples by Southern blot analysis. Hybridization of Southern blots with the Pseudomonas sp. strain B13-specific probe and a catabolic probe in conjunction with restriction fragment length polymorphism (RFLP) analysis of ribosome genes were used determine that viable Pseudomanas sp. strain B13 persisted in this environment. We also isolated a new 3-chlorobenzoate-degrading strain from one of these enrichment cultures. The B-13 specific probe does not hybridize to DNA from this isolate. The new strain could be are indigenous 3-chlorobenzoate degrader or result from gene exchange between Pseudomonas sp. strain B13 and an indigenous bacterium. The later interpretation is supported by an RFLP pattern of ribosome genes that differs from that of Pseudomonas sp. strain B13, identically sized restriction fragments hybridizing to the catabolic gene probe for the B13 chlorobenzoate pathway, and the absence of any enrichable 3-chlorobenzoate degrading strains in the aquifer prior to inoculation.

5520 Public Health

Refer also to citation(s) 6261

5530 Agriculture and Food Technology

7497 (NREL/CP–200-5768-Vol.1, pp. 309-313) **Carbon and nitrogen distribution in oak-hickory forests distributed along a productivity gradient.** Reber, R.T. (Purdue Univ., West Lafayette, IN (United States)); Kaczmarek, D.J.; Pope, P.E.; Rodkey, K.S. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.1: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 1.* 796p. Order Number DE93010050. Source: OSTI; NTIS; GPO Dep.

Biomass, carbon and nitrogen pools were determined for oak-hickory forests of varying productivity. Little information of this type is available for the central hardwood region. Six oak-hickory dominated forests were chosen to represent a range in potential site productivity as influenced by soil type, amount of recyclable nutrients and available water. Biomass, carbon and nitrogen storage were determined for the following components: above ground standing biomass, fine root biomass, forest floor organic layers and litterfall. As site sequestered at each site was dependent more on the amount of living biomass at each site Litterfall, to some extent, increased with increasing site productivity. As potential site productivity decreased, total fine root biomass increased. The data suggest that as site quality decreased fine root production and turnover may become as important in nutrient cycling as annual litterfall.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 6233, 6245, 6278, 6280, 6740, 7313, 7314, 7437, 7438, 7459, 7488, 7493, 7919

7498 (ANL/CMB/PP–81167) **HIV transcription is induced with cell killing.** Woloschak, G.E. (Argonne National Lab., IL (United States)); Schreck, S.; Chang-Liu, Chin Mei; Panozzo, J.; Libertin, C.R. Argonne National Lab., IL (United States). [1994]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94005122. Source: OSTI; NTIS; INIS; GPO Dep.

Previous work has shown that HeLa cells stably transfected with an HIV-LTR-CAT construct are induced to express chloramphenicol acetyl transferase (CAT) following exposure to DNA-damaging agents such as ultraviolet radiation, γ rays, neutrons, and others. In this report, the authors demonstrate that this induction of HIV-LTR transcription occurs when stably transfected HeLa cells are exposed to agents which mediate cell killing, such as UV radiation, electroporation of sucrose buffer, prolonged heating, and low and high pH. Cells cultured following UV exposure demonstrated a peak in CAT expression that is evidence in viable (but not necessarily cell division-competent) cells 24 h after exposure; this inductive response continued until at least 72 h after exposure. HIV-LTR induction was dose-dependent, and the amount of CAT transcription induced was correlated with the amount of cell killing that occurred in the culture. Other agents which caused no cell killing (such as heat-shock for up to 2 h, treatment with metronidazole, exposure to sunlight, vitamin C treatment, and others) had no effect on HIV-LTR induction. These results suggest that HIV transcription is induced as a consequence of the turn on of a cellular death or apoptotic pathway.

7499 (ARL-TR–095(v.2), pp. 356-393) **Operational health physics aspects of airborne and surface contamination.** Carter, M.W. (Office of the Supervising Scientist for the Alligator Rivers Region, Sydney, NSW (Australia)). Australian Radiation Lab., Melbourne, VIC (Australia). Jul 1990. In *Radiation protection in the mining and milling of radioactive ores v.2*. 180p. Order Number DE94608984. Source: OSTI; NTIS (US Sales Only); INIS.

Part of this lecture describes the derivation and use of control standards for airborne and surface contamination. The concept of derived limits is developed and sample calculations are presented. Derived dose limits for uranium and thorium are presented. Part 2 presents a range of methods of measuring contamination with some discussion of their relative merits. 29 refs., 8 tabs., 4 figs.

7500 (ARL-TR–095-Vol.1) **Radiation protection in the mining and milling of radioactive ores v.1.** Boas, J. (ed.). Australian Radiation Lab., Melbourne, VIC (Australia). Jul 1990. 266p. Order Number DE94608817. Source: OSTI; NTIS (US Sales Only); INIS.

Lecture notes from a course conducted at the Australian Radiation Laboratory, October 20-29 1987.

The main emphasis of this two week course was placed on radioactive dust as a significant or more significant contributor factor to radiation exposure than radon daughter inhalation or external gamma radiation. A two volumes technical report covers the lecture material presented during the course.

7501 (ENEA-RT-AMB–92-12) **Field parameters and operational quantities for ICRU sphere with reference photon beams: Part 1: Monte Carlo calculations of angular distribution of backscatter factors.** Gualdrini, G.F. (ENEA, Bologna (Italy). Area Energia Ambiente e Salute). No corporate text available. Apr 1993. 104p. (RT/AMB–92-12). Order Number DE94727343. Source: OSTI; NTIS (US Sales Only).

The present work is the first part of a series of Technical Reports, summarizing the various analyses carried out using Monte Carlo computational methods for the characterization of reference photon radiation fields for the calibration of personal dosemeters. For this purpose the tissue equivalent ICRU (International Commission on Radiation Units) sphere was adopted as a suitable phantom. In this first Report, which will be followed by other three Reports, a complete analysis of Backscatter Factors and their angular dependence have been carried out for five X-ray reference series as stated by the ISO (International Standards Organization) e B. I. P. M. (Bureau International de Poids et Measurements), besides Cesium and Cobalt. The results so obtained have been compared with values computed in similar conditions at other European Institutions, with satisfactory agreement. The work has been carried out under the CEC contract n 160347 and connected to the activities of EURADOS WG-4 (Computational Dosimetry).

7502 (Juel–2729) **Measuring program of the Federal Republic of Germany: External radiation exposure in the Republics of Russia and White Russia during the summer of 1992 calculated for individuals from the Briansk and Gomel regions.** Uray, I.; Hille, R. Forschungszentrum Juelich GmbH (Germany). Abt. Sicherheit und Strahlenschutz. Feb 1993. 164p. (In German). Order Number DE94734008. Source: OSTI; NTIS (US Sales Only); INIS.

The determinations of external radiation exposure basically had two aims, which were to inform the population about the external radioactive burden at the time of measurement and to provide as accurate data as possible for the various dose reconstruction procedures. The measurements were therefore carried out in different regions at systematically chosen places with widely varying contamination levels that ranged from zero to very high values. The programme yielded results for small villages and places of a more urban character alike. Each dosimeter was handed over together with a questionnaire designed to obtain some information on the social factors surrounding its bearer. (orig.)

7503 (KAERI/AR–357/92) **Laser applications for atmospheric remote sensing.** Shin, Jang Soo (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Lee, Sang Mock; Kim, Cheol Jung. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Aug 1992. 79p. (In Korean). Order Number DE94610578. Source: OSTI; NTIS (US Sales Only); INIS.

One of the most important thing to solve the environmental pollution problems are to establish a measurement technique to detect the kind and the type of pollution timely, quantitatively and qualitatively with accuracy and precision. The conventional measurement techniques such as wet analysis methods and spectrophotometric methods are generally time-consuming and require many manpowers, so it is apt to induce relatively higher errors in analytical processes. The application of laser for environmental remote sensing is the most powerful candidate to overcome the abovementioned drawbacks of the conventional methods. In this report, we propose the possibility of laser application for environmental sensing. (Author).

7504 (LA–12538-MS) **Multisphere neutron spectroscopy measurements at the Los Alamos National Laboratory Plutonium Facility.** Harvey, W.F. (Los Alamos National Lab., NM (United States)); Hajnal, F. Los Alamos National Lab., NM (United States). Jun 1993. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003509. Source: OSTI; NTIS; INIS; GPO Dep.

Multisphere neutron spectroscopy methods are applied to measure representative working fields within the Los Alamos National Laboratory (LANL) Plutonium Facility. This facility hosts dynamic processes, which include the fabrication of ^{238}Pu heat sources for radioisotope generators used to power space equipment and a variety of plutonium research programs that involve recovery, hydrofluorination, and metal production. Neutron fluence per unit lethargy, as a function of neutron energy measured for locations throughout this facility, are described. Dosimeter/remmeter response functions [e.g., determined for a 22.8-cm-diameter neutron rem detector (NRD), an Anderson/Braun-type neutron "Snoopy" monitor, track-etch CR-39, BDI-100 bubble detectors, and Kodak type A nuclear track emulsion film, (NTA)] are folded into these spectra to calculate absolute response values of counts, tracks, or bubbles per unit-dose equivalent. The relative response values per unit- dose equivalent for bare and albedo ^{6}LiF-based thermoluminescent dosimeters (TLDs) are also calculated to estimate response scenarios encountered with use of the LANL-TLD. These

results are further compared to more conventional methods of estimating neutron spectral energies such as the "9-to-3 ratio" method.

7505 (NUREG–0713-Vol.14) **Occupational radiation exposure at commercial nuclear power reactors and other facilities 1992: Twenty-fifth annual report, Volume 14.** Raddatz, C.T. (US Nuclear Regulatory Commission, Washington, DC (United States). Division of Regulatory Applications); Hagemeyer, D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Regulatory Applications. Dec 1993. 295p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This report summarizes the occupational radiation exposure information that has been reported to the NRC's Radiation Exposure Information Reporting System (REIRS) by nuclear power facilities and certain other categories of NRC licensees during the years 1969 through 1992. The bulk of the data presented in the report was obtained from annual radiation exposure reports submitted in accordance with the requirements of 10CFR20.407 and the technical specifications of nuclear power plants. Data on workers terminating their employment at certain NRC licensed facilities were obtained from reports submitted pursuant to 10CFR20.408. The 1992 annual reports submitted by about 364 licensees indicated that approximately 204,365 individuals were monitored, 183,927 of whom were monitored by nuclear power facilities. They incurred an average individual dose of 0.16 rem (cSv) and an average measurable dose of about 0.30 (cSv). Termination radiation exposure reports were analyzed to reveal that about 74,566 individuals completed their employment with one or more of the 364 covered licensees during 1992. Some 71,846 of these individuals terminated from power reactor facilities, and about 9,724 of them were considered to be transient workers who received an average dose of 0.50 rem (cSv).

7506 (PNWD–2200-HEDR) **Final report on the meteorological database, December 1944–1949: Hanford Environmental Dose Reconstruction Project.** Stage, S.A.; Ramsdell, J.V. Jr.; Simonen, C.A.; Burk, K.W.; Berg, L.K. Pacific Northwest Lab., Richland, WA (United States). Nov 1993. 124p. Sponsored by Department of Health and Human Services, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94002952. Source: OSTI; NTIS; INIS; GPO Dep.

The Hanford Environmental Dose Reconstruction (HEDR) Project is estimating radiation doses that individuals may have received from operations at Hanford from 1944 to the present. A number of computer programs are being developed by the HEDR Project to estimate doses and confidence ranges associated with radionuclides transported through the atmosphere and the Columbia River. One computer program is the Regional Atmospheric Transport Code for Hanford Emissions Tracking (RATCHET). RATCHET combines release data with information on atmospheric conditions including wind direction and speed. The RATCHET program uses these data to produce estimates of time-integrated air concentrations and surface contamination. These estimates are used in calculating dose by the Dynamic EStimates of Concentrations And Radionuclides in Terrestrial EnvironmentS (DESCARTES) and the Calculations of Individual Doses from Environmental Radionuclides (CIDER) computer programs. This report describes the final status of the meteorological database used by RATCHET. Data collection procedures and the preparation and control of the meteorological database are described, along with an assessment of the data quality.

7507 (RFP–4747) **Qualitative safety analysis of proposed material relocation options.** Cathey, N.G.; Foppe, T.L. EG and G Rocky Flats, Inc., Golden, CO (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC34-90RF62349. (CONF-940312–26: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001391. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents the methodology used to perform a qualitative safety analysis of various options proposed for the relocation of Special Nuclear Material from its present locations to other areas of the Rocky Flats Plant. This analysis determined the relative risk ranking of various proposed relocation options considering the probability and consequences of accidents associated with the material handling, transportation, and storage locations. Of of the five options, two grouping of results were concluded to be significantly different, allowing the decision makers to balance risk issues with their other requirements (e.g., security, schedule, etc.).

7508 (UCRL-JC–115068) **Practical aspects of shielding high-energy particle accelerators.** Thomas, R.H. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). Sep 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9310242–2: 18. annual conference of the Australian Radiation Protection Society, Sydney (Australia), 7 Oct 1993). Order Number DE94004199. Source: OSTI; NTIS; INIS; GPO Dep.

The experimental basis of shielding design for high-energy accelerators that has been established over the past thirty years is described. Particular emphasis is given to the design of large accelerators constructed underground. The first data obtained from cosmic-ray physics were supplemented by basic nuclear physics. When these data proved insufficient, experiments were carried out and interpreted by several empirical formulae – the most successful of which has been the Moyer Model. This empirical model has been used successfully to design the shields of most synchrotrons currently in operation, and is still being used in preliminary design and to check the results of neutron transport calculations. Accurate shield designs are needed to reduce external radiation levels during accelerator operations and to minimize environmental impacts such as "skyshine" and the production of radioactivity in groundwater. Examples of the cost of minimizing such environmental impacts are given.

7509 (UCRL-JC–115071) **Accelerators in our past, present, and future: A challenge to radiological protection in the twenty-first century.** Thomas, R.H. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9310242–1: 18. annual conference of the Australian Radiation Protection Society, Sydney (Australia), 7 Oct 1993). Order Number DE94004198. Source: OSTI; NTIS; GPO Dep.

The foundations of many of the subdisciplines of radiological protection laid in accelerator laboratories began with the invention of accelerators. This paper suggests that the discipline of accelerator radiological protection has played and will continue play a more significant part in our lives than is generally recognized. A brief review of some existing uses of accelerators by society is given, and a few probable future uses are described. These future applications will result in the exposure of accelerator (or "mixed") radiation fields to an increased population. Consequently, what are perceived to be the rather specialized concerns of today's accelerator health physicists will – by necessity – become of general interest to all health physicists.

7510 (Y/DQ–49/R1) **Internal dosimetry performing dose assessments via bioassay measurements.** Bailey, K.M. Oak Ridge Y-12 Plant, TN (United States). 11 May 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OS21400. Order Number DE94003331. Source: OSTI; NTIS; INIS; GPO Dep.

The Internal Dosimetry Department at the Y-12 Plant maintains a state-of-the-art bioassay program managed under the guidance and regulations of the Department of Energy. The two major bioassay techniques currently used at Y-12 are the in vitro (urinalysis) and in vivo (lung counting) programs. Fecal analysis (as part of the in vitro program) is another alternative; however, since both urine and fecal analysis provide essentially the same capabilities for detecting exposures to uranium, the urinalysis is the main choice primarily for aesthetic reasons. The bioassay frequency is based on meeting NCRP 87 objectives which are to monitor the accumulation of radioactive material in exposed individuals, and to ensure that significant depositions are detected.

5603 Chemicals Metabolism and Toxicology

Refer also to citation(s) 7398, 7455, 7463

7511 (DOE/EW/50625–T13) **Environmental Hazards Assessment Program: Quarterly report, July–September 1993.** Medical Univ. of South Carolina, Charleston, SC (United States). [1993]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92EW50625. Order Number DE94004493. Source: OSTI; NTIS; GPO Dep.

The objectives of the EHAP program stated in the proposal to DOE are to: (1) develop a holistic, national basis for risk assessment, risk management, and risk communication which recognizes the direct impact of environmental hazards on the health and well-being of all, (2) develop a pool of talented scientists and experts in cleanup activities, especially in human health aspects, and (3) identify needs and develop programs addressing the critical shortage of well-educated, highly-skilled technical and scientific personnel to address the health oriented aspects of environmental restoration and waste management.

7512 (NREL/CP–200-5768-Vol.2, pp. 1326-1331) **Biodegradable lignin/polyolefin composite films.** Kosikova, B. (Slovak Academy of Sciences, Bratislava (Slovakia)); Demjanova, V.; Mikulasova, M.; Lora, J.H. National Renewable Energy Lab., Golden, CO (United States). [1993]. (CONF-9308106–Vol.2: 1. biomass conference of the Americas: energy, environment, agriculture, and industry, Burlington, VT (United States), 30 Aug - 2 sep 1993). In *First Biomass Conference of the Americas: Energy, environment, agriculture, and industry: Proceedings, Volume 2.* 711p. Order Number DE94000435. Source: OSTI; NTIS; GPO Dep.

From the view point of environmental protection, the plastic wastes, especially from packing materials, represent a potential waste problem. Various approaches were examined to develop partially or completely biodegradable plastics. New type of partially biodegradable polyolefins was prepared by blending of polypropylene with lignin, which was recovered in the ALCELL process, an organosolv pulping process that uses ethanol-water as the delignifying agent. Films of blends with up to 10% wt ALCELL lignin, prepared in absence of commercial stabilizers, had acceptable mechanical strengths. The effect of iignin on biodegradability of the composite films was examined by comparison of behaviour of both pure and lignin containing films during treatment with fungus Phanerochaete chrysosporium. It was found that this fungus is able to grow and to produce lignolytic enzymes in the presence of the films containing lignin. Biodegradation of lignin in the composite film was confirmed by the releasing of lignin fragments into the extracellular fluid. Because of measurement of mechanical properties offers a mean of direct estimation of polymer degradation, the degree of biodegradation of the films tested was followed by monitoring of elongation at break. The changes of break at elongation in the course of enzymatic treatment revealed that the lignin/PP composite films are potentially environmentally nonpersisting. The micrographs of the lignin containing films obtained by scanning electron microscopy show the significant changes of the film surface upon degradation with Phanerochaete chrysosporium in contrast to unchanged lignin free film.

5604 Other Environmental Pollutant Effects

Refer also to citation(s) 6751

7513 (UCRL-ID–115334) **Initial ultraviolet-B intensity data at Lawrence Livermore National Laboratory.** Patten, K.O. Jr. (Lawrence Livermore National Lab., CA (United States)); Wuebbles, D.J.; Smith, G.J. Lawrence Livermore National Lab., CA (United States). Oct 1993. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004279. Source: OSTI; NTIS; GPO Dep.

A measurement of UV-B reaching the ground has been established at the Lawrence Livermore National Laboratory. The instrument is the same as those operated by the National Institute for Water and Atmospheric Research in their network in New Zealand. The wavelength response of the radiometer is similar to the response of human skin to UV-B. Intensity data are collected by averaging meter readings over 10 minutes from 6:00 am to 6:00 pm Pacific Standard Time, then converting to effective UV-B intensity normalized at 310 nm. This report checks the intensities obtained at LLNL from November 1992 to July 1993 against the expected results: Increased solar zenith angle, whether from the daily cycle or from the yearly cycle in solar position, should decrease UV-B intensity at the ground due to increased optical path; and, intervening cloud cover should decrease ground UV-B intensity. Three additional findings are reported here: Maximum UV-B intensity on cloudless days does not always follow a smooth curve, but instead varies either high or low to some extent; Morning UV-B intensities are less than those in the afternoon at comparable solar zenith angles at certain times of year; LLNL wintertime daily-averaged UV-B intensities are somewhat higher than those observed at Auckland, New Zealand in their winter of 1992.

57 HEALTH AND SAFETY

Refer also to citation(s) 6264, 7375

7514 (LA-UR–93-3283) **Classification of superficial lesions of the eye with an optical biopsy system: First trials with the Los Alamos instrument.** Glickman, R.D. (Texas Univ. Health Science Center, San Antonio, TX (United States)); Gritz, D.C.; Held, K.S.; Bigio, I.J.; Johnson, T.; Loree, T.R.; Mourant, J.R.; Shimada, T. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by Texas Univ., Austin, TX (United States). DOE Contract W-7405-ENG-36. (CONF-940223–1: Vision science and its applications, Santa Fe, NM (United States), 11-15 Feb 1994). Order Number DE94000900. Source: OSTI; NTIS; GPO Dep.

the clinical diagnosis of a lesion often requires that a histological analysis be made of a physical specimen of the suspect tissue. In the present work, the authors have utilized an optical biopsy system (OBS) developed at Los Alamos National Laboratory which is safe for patient use and provides a large amount of optical data from the sampled tissue. An earlier version of this system has been used to study age-related changes in the ocular lens (10). The purpose of the present study is to establish the potential clinical utility of the OBS by determining if characteristic features in the optical signatures, obtained from a variety of ophthalmic lesions, are correlated with the histological features of tissue biopsies obtained from these patients.

58 GEOSCIENCES

Refer also to citation(s) 6082, 6153, 6192, 6202, 6282, 7175, 7389, 7401, 7444, 7446, 7451, 7452

7515 (DOE/ER–0597P) **Summaries of FY 1993 geosciences research.** USDOE Office of Energy Research, Washington, DC (United States). Engineering and Geosciences Div. Dec 1993. 155p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94004710. Source: OSTI; NTIS; GPO Dep.

The Department of Energy supports research in the geosciences in order to provide a sound foundation of fundamental knowledge in those areas of the geosciences that are germane to the DOE's many missions. The Geosciences Research Program is supported by the Office of Energy Research. The participants in this program include DOE laboratories, academic institutions, and other governmental agencies. These activities are formalized by a contract or grant between the DOE and the organization performing the work, providing funds for salaries, equipment, research materials, and overhead. The summaries in this document, prepared by the investigators, describe the scope of the individual programs. The Geosciences Research Program includes research in geophysics, geochemistry, resource evaluation, solar-terrestrial interactions, and their subdivisions including earth dynamics, properties of earth materials, rock mechanics, underground imaging, rock-fluid interactions, continental scientific drilling, geochemical transport, solar-atmospheric physics, and modeling, with emphasis on the interdisciplinary areas.

7516 (DOE/ER/14079–29) **Efficient modeling in transversely isotropic inhomogeneous media.** Alkhalifah, T. Colorado School of Mines, Golden, CO (United States). Center for Wave Phenomena. Nov 1993. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER14079. (CWP–129P). Order Number DE94003394. Source: OSTI; NTIS; GPO Dep.

An efficient modeling technique for transversely isotropic, inhomogeneous media, is developed using a mix of analytical equations and numerical calculations. The analytic equation for the raypath in a factorized transversely isotropic (FTI) media with linear velocity variation, derived by Shearer and Chapman, is used to trace between two points. In addition, I derive an analytical equation for geometrical spreading in FTI media that aids in preserving program efficiency; however, the traveltime is calculated numerically. I then generalize the method to treat general transversely isotropic (TI) media that are not factorized anisotropic inhomogeneous by perturbing the FTI traveltimes, following the perturbation ideas of Cerveny and Filho. A Kirchhoff-summation-based program relying on Trorey's (1970) diffraction method is used to generate synthetic seismograms for such a medium. For the type of velocity models treated, the program is much more efficient than finite-difference and general ray-trace modeling techniques.

7517 (DOE/ER/14113–3) **Hyperfiltration-induced fractionation of lithium isotopes in geologic systems: Progress report, April 1, 1992–June 30, 1993.** Fritz, S.J. Purdue Univ., Lafayette, IN (United States). Dept. of Earth and Atmospheric Sciences. Jun 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER14113. Order Number DE94003520. Source: OSTI; NTIS; GPO Dep.

The purpose of this research was to show whether hyperfiltration is an efficient mechanism to fractionate lithium isotopes. This paper reports results of experiments in which freeze-dried, LiCl-saturated bentonite is sedimented onto a chemically inert filter paper fitted to a porous plug. The filter is connected to a syringe pump capable of delivering solution at a precisely controlled flow rate. Deionized water is forced through the membrane to determine its hydraulic conductivity. The deionized water is then changed to 9.411 mN LiCl solution. The $^{7}Li/^{6}Li$ ratio is measured for the input solution as well as the effluent. The concentration profile for ^{6}Li and ^{7}Li can then be computed. These experiments have shown lithium isotope fractionation by hyperfiltration through geologic materials.

7518 (LA-UR–93-3951) **SPECTRUM analysis of multi-spectral imagery in conjunction with wavelet/KLT data compression.** Bradley, J.N.; Brislawn, C.M. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9311135–2: Institute of Electrical and Electronic Engineers (IEEE) asilomar conference on signals, systems, and computers, Pacific Grove, CA (United States), 1-3 Nov 1993). Order Number DE94003961. Source: OSTI; NTIS; GPO Dep.

The data analysis program, SPECTRUM, is used for fusion, visualization, and classification of multi-spectral imagery. The raw data used in this study is Landsat Thematic Mapper (TM) 7-channel imagery, with 8 bits of dynamic range per channel. To facilitate data transmission and storage, a compression algorithm is proposed based on spatial wavelet transform coding and KLT decomposition of interchannel spectral vectors, followed by adaptive optimal multiband scalar quantization. The performance of SPECTRUM clustering and visualization is evaluated on compressed multispectral data. 8-bit visualizations of 56-bit data show little visible distortion at 50:1 compression and graceful degradation at higher compression ratios. Two TM images were processed in this experiment: a 1024 x 1024-pixel scene of the region surrounding the Chernobyl power plant, taken a few months before the reactor malfunction, and a 2048 x 2048 image of Moscow and surrounding countryside.

7519 (LA-UR–93-4265) **MUSIC for localization of thunderstorm cells.** Mosher, J.C. (Los Alamos National Lab., NM (United States)); Lewis, P.S.; Rynne, T.M. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9311135–4: Institute of Electrical and Electronic Engineers (IEEE) asilomar conference on signals, systems, and computers, Pacific Grove, CA (United States), 1-3 Nov 1993). Order Number DE94004985. Source: OSTI; NTIS; GPO Dep.

Lightning represents an event detectable optically, electrically, and acoustically, and several systems are already in place to monitor such activity. Unfortunately, such detection of lightning can occur too late, since operations need to be protected in advance of the first lightning strike. Additionally, the bolt itself can traverse several kilometers before striking the ground, leaving a large region of uncertainty as to the center of the storm and its possible strike regions. NASA Kennedy Space Center has in place an array of electric field mills that monitor the (effectively) DC electric field. Prior to the first lightning strike, the surface electric fields rise as the storm generator within a thundercloud begins charging. Extending methods we developed for an analogous source localization problem in mangnetoencephalography, we present Cramer-Rao lower bounds and MUSIC scans for fitting a point-charge source model to the electric field mill data. Such techniques can allow for the identification and localization of charge centers in cloud structures.

7520 (LBL–30751) **Development and verification of a numerical technique for coupled hydromechanical phenomena in rocks.** Noorishad, J.; Tsang, C.F. Lawrence Berkeley Lab., CA (United States). Jun 1990. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-900640–8: International conference on rock joints, Loen (Norway), 4-6 Jun 1990). Order Number DE94004006. Source: OSTI; NTIS; GPO Dep.

Analysis of hydromechanical behavior of fractured rocks requires the use of a numerical method, such as the ROCMAS code developed at LBL (Noorishad et al, 1982). A new numerical technique composed of an incremental recasting of the finite element matrix formulation of the hydroelasticity algorithms, coupled with a modified Newton-Raphson linearization scheme, is developed for such analysis. The resulting code, which was named ROCMAS II, was partially verified using existing solutions in the literature. Complete verification was obtained by cross comparison of the performance of ROCMAS II versus that of its predecessor, the ROCMAS code, since the solution techniques of these two codes are completely different. The verified ROCMAS II with its major improvements, such as an incremental set-up, the strain-softening and dilating shear, and hyperbolic normal closure joint model, and the new linearization scheme, allows more realistic simulations of a host of rock mechanic problems in saturated rocks. Furthermore, the ROCMAS II set-up provides a proper basis upon which procedures for general treatment of various kinds of material non-linearity can be built.

7521 (UCRL-ID–115322) **Simulation of the Indian and East-Asian summer monsoon in the ECMWF model: Sensitivity to horizontal resolution.** Sperber, K.R. (Lawrence Livermore National Lab., CA (United States)); Potter, G.L.; Boyle, J.S.; Hameed, S. Lawrence Livermore National Lab., CA (United States). Nov 1993. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (PCMDI–12). Order Number DE94004276. Source: OSTI; NTIS; GPO Dep.

The ability of the ECMWF model (Cycle 33) to simulate the Indian and East Asian summer monsoon is evaluated at four different horizontal resolutions: T21, T42, T63, and T106. Generally, with respect to the large scale features of the circulation, the largest differences among the simulations occur at T42 relative to T21. However, on regional scales, important differences among the high frequency temporal variabilitY serve as a further critical test of the model's ability to simulate the monsoon. More generally, the results indicate the importance of evaluating high frequency time scales as a component of the climate system. T106 best captures both the spatial and temporal characteristics of the Indian and East Asian Monsoon, while T42 fails to correctly simulate the sequence and development of synoptic scale milestones that characterize the monsoon flow. In particular, T106 is superior at simulating the development and migration of the monsoon trough over the Bay of Bengal. In the T42 simulation, the development of the monsoon occurs one month earlier than typically observed. At this time the trough is incorrectly located adjacent to the east coast of India which results in an underestimate of precipitation over the Burma/

Thailand region. This early establishment of the monsoon trough affects the evolution of the East-Asian monsoon and yields excessive preseason rainfall over the Mei-yu region. EOF analysis of precipitation over China indicates that T106 best simulates the Mei-yu mode of variability associated with an oscillation of the rainband that gives rise to periods of enhanced rainfall over the Yangize River Valley. The coarse resolution of T21 precludes simulation of the aforementioned regional scale monsoon flows.

7522 (UCRL-ID–115335) **Numerical procedure for planetary wave solution.** Choi, Woo Kap; Wuebbles, D.J. Lawrence Livermore National Lab., CA (United States). Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004280. Source: OSTI; NTIS; INIS; GPO Dep.

The newly-developed LLNL two-dimensional chemical-radiative-transport model requires a knowledge of the EP flux divergence as an input momentum forcing. The major contributions for this forcing term come from the synoptic wave in the troposphere, the planetary wave in the stratosphere and mesosphere and the gravity wave in the upper mesosphere. The major source of the zonal momentum forcing in the middle atmosphere is the nonlinear planetary wave breaking. This planetary wave breaking also plays a significant role of mixing the chemical tracers. Garcia suggested a way of parameterizing the planetary wave breaking by using, linear damping of the primary wave. In this note we describe the procedure of obtaining the wave solution for the parameterization.

7523 (UCRL-JC–112788) **The effect of elevation data representation on nocturnal drainage wind simulations.** Walker, H.; Leone, J.M. Jr. Lawrence Livermore National Lab., CA (United States). Aug 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9309230–3: 2. international workshop in integrating geographic information systems and environmental modeling, Breckenridge, CO (United States), 27-29 Sep 1993). Order Number DE94003624. Source: OSTI; NTIS; GPO Dep.

A critical requirement for accurately representing surface-atmosphere interactions within an atmospheric model is to realistically characterize the land surface. Data must be extracted from a geographical database and transformed so that it is consistent with the needs of the numerical model. In such a process, there are two major classes of error that must be understood and minimized whenever possible. The first class involves the accuracy, precision, and resolution of the geographical data itself. The second is error introduced by the transformations used to assimilate the data into the atmospheric model. Thus, this research has two coupled objectives: to understand the effects of errors within the geographical data base upon the accuracy of the atmospheric model simulation and to design optimal techniques for the transformation of the data. Such transformations are often constrained by the conflicting needs of representing physically important spatial and temporal scales while eliminating scales that cannot be resolved by the a model.

66 PHYSICS

7524 (DOE/FTR–93018043) **Travel to the first congress of the Institute of Physics with topics including the vacuum, plasma, spectroscopy, and physics in medicine topical groups: Foreign trip report, April 17–23, 1993.** Dylla, H.F. Southeastern Universities Research Association, Inc., Newport News, VA (United States). Continuous Electron Beam Accelerator Facility. 19 Jul 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84ER40150. Order Number DE93018043. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This meeting was the first congress offered by the Institute of Physics (IOP) that combined symposia organized by several topical groups of the IOP, including the vacuum, plasma, spectroscopy, and physics in medicine topical groups. Approximately 300 physicists attended the congress. The traveler was invited by the IOP Vacuum Group to present an invited talk on "The Modeling and Measurement of Water Outgassing from Metal Surfaces." In addition, the traveler was invited by the President of IOP, Dr. Clive Foxell, to represent the American Vacuum Society (as current AVS President) at several ceremonial functions during the congress.

6611 Classical and Quantum Mechanics

Refer also to citation(s) 7583, 7593

7525 (BONN-HE–93-13) **Low-temperature expansions and correlation functions of the Z_3-chiral Potts model.** Han, N.S.; Honecker, A. Bonn Univ. (Germany). Physikalisches Inst. Apr 1993. 17p. (HEP-TH–9304083). Order Number DE94734005. Source: OSTI; NTIS (US Sales Only); INIS.

Using perturbative methods we derive new results for the spectrum and correlation functions of the general Z_3-chiral Potts quantum chain in the massive low-temperature phase. Explicit calculations of the ground state energy and the first excitations in the zero momentum sector give excellent approximations and confirm the general statement that the spectrum in the low-temperature phase of general Z_n-spin quantum chains is identical to one in the high-temperature phase where the role of charge and boundary conditions are interchanged. Using a perturbative expansion of the ground state for the Z_3 model we are able to gain some insight in correlation functions. We argue that they might be oscillating and give estimates for the oscillation length as well as the correlation length. (orig.)

7526 (BUDKERINP–91-74) **Collective dynamics of unstable quantum states.** Sokolov, V.V.; Zelevinskij, V.G. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1991. 47p. (IYaF–91-74.). Order Number DE94611072. Source: OSTI; NTIS (US Sales Only); INIS.

Dynamics of a complicated quantum system interacting with open decay channels is treated by means of the discretized effective non-Hermitian Hamiltonian. The main subject is segregation of collective short-lived resonances, which are similar to the coherent Dicke states in optics. The analysis is carried out with use of two complementary representations (internal and doorway). The phase transition between regimes of weak and strong continuum coupling is considered. 32 refs.

7527 (BUDKERINP–91-98) **Level density of random matrices for decaying systems.** Haake, F.; Izrailev, F.; Saher, D.; Sommers, H.-J. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1991. 10p. (IYaF–91-98.). Order Number DE94611073. Source: OSTI; NTIS (US Sales Only); INIS.

Analytical and numerical results for the level density of a certain class of random non-Hermitian matrices $H=H+i\Gamma$ are presented. The conservative part H belongs to the Gaussian orthogonal ensemble while the damping piece Γ is quadratic in Gaussian random numbers and may describe the decay of resonances through various channels. In the limit of a large matrix dimension the level density assumes a surprisingly simple dependence on the relative strength of the damping and the number of channels. 18 refs.; 4 figs.

7528 (BUDKERINP–92-1) **The 2+1-dimensional integrable generalization of the sine-Gordon equation: Dressing method and initial value problem.** Konopel'chenko, B.G.; Dubrovskij, V.G. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1992. 53p. (IYaF–92-1.). Order Number DE94611074. Source: OSTI; NTIS (US Sales Only); INIS.

The 2+1-dimensional integrable generalization of the sine-Gordon equation symmetric in the spatial variables is studied by the inverse spectral transform method. The solutions with functional parameters, plane solitons (kinks) and plane breathers are constructed by the dressing method. The initial value problem for this equation with the constant boundaries is solved in both cases $\sigma^2=\pm 1$. 21 refs.

7529 (IC–93/233) **Coherent states versus De Broglie-Wavelets.** Barut, A.O. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 7p. Order Number DE94611075. Source: OSTI; NTIS (US Sales Only); INIS.

There are two types of nonspreading localized wave forms representing a stable, individual, indivisible, single quantum particle with interference properties endowed with classical (hidden) parameters, i.e. initial positions and velocity: coherent states and

wavelets. The first is exactly known for oscillator, the second for free particles. Their relation and their construction is discussed from a new unified point of view. We then extend this contraction to the Coulomb problem, where with the introduction of a new time variable T, nonspreading states are obtained. (author). 10 refs.

7530 (JINR-D–2-92-552) **Ives-Stilwell experiment and relativistic length.** Strel'tsov, V.N. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of High Energy. 1992. 10p. (In Russian). Order Number DE94611076. Source: OSTI; NTIS (US Sales Only); INIS.

The radar formulation of the relativistic theory operates with light or retarded distances and relativistic or radar length introduced on their basis. In spite of this the aberration of light should be considered as the first manifestation of the light distance. 24 refs.; 2 figs.

7531 (JINR-E–2-92-359) **On calculation of evolution operator kernel of Schroedinger equation.** Slobodenyuk, V.A. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 15p. Order Number DE94611077. Source: OSTI; NTIS (US Sales Only); INIS.

The method for calculation of the evolution operator kernel as an expansion in powers of the time interval δt is proposed. 17 refs.

7532 (JINR-R–4-92-496) **To the qualitative theory of the multichannel quantum systems.** Zakhar'ev, B.N. (Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics); Chabanov, V.M.; Nekhamkin, V.M. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 12p. (In Russian). Order Number DE94611078. Source: OSTI; NTIS (US Sales Only); INIS.

It is clarified that the elementary constituents of the multichannel formalism are: the algorithms of the spectral management of the wave motion along the continuous x (spatial) and discrete a (numbering the channels) co-ordinates. The perturbations which change the partial reduced widths of bound states are considered as well. 14 refs.; 2 figs.

7533 (KAERI/TR–367/93) **Magnetic field effect on selective photoionization.** Lee, Jong Min (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Yoo, Byung Duk; Lee, Young Joo; Cha, Hyung Ki; Choe, Ang Sung; Rho, Si Pyo; Baik, Dae Hyun; Song, Kyu Seok; Yi, Jong Hoon; Jeong, Do Young; Jeong, Eui Chang; Han, Jae Min; Yang, KKorea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jul 1993. 49p. (In Korean). Order Number DE94611079. Source: OSTI; NTIS (US Sales Only); INIS.

The magnetic field effects on selective photoionization of the atoms of Lanthanides have been examined in a point of view of the enhancement of the efficiency of selective photoionization. The Zeeman shifts and the hyperfine structures have been calculated by the formulae approximated by LS coupling, and the electronic orbitals by the Hartree-Slater equation. The dependence of the energy levels on the magnetic field has been informed. The photoionization rate due to the polarized lights in a magnetic field has been evaluated. The variation of selection rules of the photoionization due to polarized lights, also, has been informed. (Author).

7534 (KFKI–1993-07/B) **Kerr-Schild metrics revisited. Pt. 1: The ground state.** Gergely, L.A.; Perjes, Z. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. 20p. Order Number DE94611080. Source: OSTI; NTIS (US Sales Only); INIS.

The particular way Kerr-Schild metrics incorporate a congruence of null curves in space-time is a sure source of fascination. The Kerr-Schild pencil of metrics $g_{ab}+\Delta l_a l_b$ is investigated in the generic case when it maps an arbitrary vacuum space-time with metric g_{ab} to a vacuum space-time. The theorem is proved that this generic case does not contain the shear-free subclass as a smooth limit. It is shown that one of the Kota-Perjes metrics is a solution in the shearing class. (R.P.) 15 refs.

7535 (KFKI–1993-09/B) **Kerr-Schild metrics revisited. Pt. 2: The homogeneous integrals.** Gergely, L.A.; Perjes, Z. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. 21p. Order Number DE94611081. Source: OSTI; NTIS (US Sales Only); INIS.

The vacuum-vacuum Kerr-Schild pencil of metrics $g_{ab}+Vl_a l_b$ in the generic case in an anharmonic dynamical system governed by two constrained sets ψ_1 and ψ_2 of first-order linear differential equations. The ψ_1 system is homogeneous, and provides the source terms for the ψ_2 system nonlinearly. The general solution of the homogeneous equations is obtained. (R.P.) 6 refs.; 3 tabs.

7536 (LA-UR–93-4316) **(j,0) ⊕ (0,j) representation space: Majorana-like construct.** Ahluwalia, D.V.; Goldman, T.; Johnson, M.B. Los Alamos National Lab., NM (United States). [1993]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9309304–1: 17. International School of Theoretical Physics meeting on standard model and beyond, Krakow (Poland), Sep 1993). Order Number DE94005010. Source: OSTI; NTIS; INIS; GPO Dep.

This is second of the two invited lectures presented at the "XVII International School of Theoretical Physics: Standard Model and Beyond' 93." The text is essentially based on a recent publication by the present authors. Here, after briefly reviewing the (j, 0) ⊕ (0, j) Dirac-like construct in the front form, we present a detailed construction of the (j, 0) ⊕ (0, j) Majorana-like fields.

6612 Techniques of General Use in Physics

7537 **Particle beam generator using a radioactive source.** Underwood, D.G. To Dept. of Energy. 1991. U.S. patent application 7-798,782. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94005172. Source: OSTI; NTIS; INIS; GPO Dep.

The apparatus of the present invention selects from particles emitted by a radioactive source those particles having momentum within a desired range and focuses the selected particles in a beam having at least one narrow cross-dimension, and at the same time attenuates potentially disruptive gamma rays and low energy particles. Two major components of the present invention are an achromatic bending and focusing system, which includes sector magnets and quadrupole, and a quadrupole doublet final focus system. Permanent magnets utilized in the apparatus are constructed of a ceramic (ferrite) material which is inexpensive and easily machined.

6613 Other Aspects of Physical Science

Refer also to citation(s) 6484, 7359, 7367, 7576

7538 (DOE/ER/75531–1) **Predoctoral training grant in the area of physical sciences: Final technical report, October 1989–October 1993.** Venkateswarlu, P. Alabama A and M Univ., Normal, AL (United States). Dept. of Physics. Nov 1993. 55p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-89ER75531. Order Number DE94004406. Source: OSTI; NTIS; INIS; GPO Dep.

This final technical report represents the results of the research in nonlinear optics (optical phase conjugation) obtained by five (5) predoctoral students in the department of physics at Alabama Agricultural and Mechanical University (AAMU).

7539 (FNAL/C–93/346) **Sloan Digital Sky Survey.** Kent, S.M. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9309298–1: Science with infrared surveys conference, Les Houches (France), 21-24 Sep 1993). Order Number DE94004662. Source: OSTI; NTIS; INIS; GPO Dep.

The Solan Digital Sky Survey is a project which will produce a detailed digital phometric map of half the northern sky to about 23 magnitude using a special purpose wide field telescope of 2.5 meter aperture. This map will be used to select about a million galaxies and 100,000 quasars, for which high resolution spectra will be obtained using the same telescope. A catalog will be produced of all the detected objects, about 100 million galaxies and a similar number of stars, and a million quasar candidates.

7540 (IC–93/252) **Magnetoresistance of films and strips with the diffuse surface scattering.** Aronov, A.G. International

Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 13p. Order Number DE94611100. Source: OSTI; NTIS (US Sales Only); INIS.

Magnetoresistance of films in a parallel magnetic field and strips in a perpendicular field is considered. The temperature and magnetic field dependencies of magnetoconductance depend on the time evolution of the correlator of phases. This correlator has different behavior as the function of time: the ergodic behavior at small magnetic fields is changed on the nonergodic one at large magnetic fields in spite of the diffusion electron motion due to a diffuse scattering on boundaries. This leads to unusual temperature and magnetic field dependencies of magnetoresistance. The ergodic hypothesis is not applicable to mesoscopical fluctuations at such a large quasiclassical field. (author). 6 refs, 5 figs.

7541 (IC–93/267) **Intensity of waves diffracted from symmetrical profile lamellar gratings.** Chakrabarti, S. (International Centre for Theoretical Physics, Trieste (Italy)); Chakravorty, J.N. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 15p. Order Number DE94611101. Source: OSTI; NTIS (US Sales Only); INIS.

We derive the expression for the intensity of the diffracted waves from a symmetrical profile lamellar grading (SLG). Such symmetrical structure may improve the performance of an ordinary lamellar grating. If suitably designed, its applicability may be extended to the millimeter to radio wave regions apart from the normal optical and near infrared region in which it is mostly used. Such millimeter wave SLG can have significant application in astronomy and astrophysics. By proper choice of geometrical parameters, an SLG may be used as a microwave antenna in space communication as well. (author). 24 refs, 5 figs.

7542 (IC–93/268) **Some theorems on a class of harmonic manifolds.** Rahman, M.S.; Chen Weihuan. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 9p. Order Number DE94611102. Source: OSTI; NTIS (US Sales Only); INIS.

A class of harmonic n-manifold, denoted by HM_n, is, in fact, focussed on a Riemannian manifold with harmonic curvature. A variety of results, with properties, on HM_n is presented in a fair order. Harmonic manifolds are then touched upon manifolds with recurrent Ricci curvature, biRicci-recurrent curvature and recurrent conformal curvature, and, in consequence, a sequence of theorems are deduced. (author). 21 refs.

7543 (IC–93/269) **A theoretical study of ordering phenomena in K-In and K-Sb molten alloys.** Akinlade, O.; Badirkhan, Z. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 18p. Order Number DE94611103. Source: OSTI; NTIS (US Sales Only); INIS.

The quasilattice approximation (QLA) has been used to study ordering phenomena in K-In and K-Sb alloys. The concentration-concentration fluctuations in the long wavelength limit $S_{cc}(0)$, the Watten-Cowley short range order parameter α_1 and the chemical diffusion D have been computed. Our calculations yield for both alloys, qualitative agreement with experiment in the transition from a compound forming/phase separating (CF/PS) state observed in K-In to strong compound formation in the case of K-Sb. Most importantly, we obtain the calculated quantities for the whole concentration range, thus complementing the available experimental evidence. Based on the present work and our previous calculations for K-Te, we predict that from an ordering point of view and within the same framework of the QLA, K-Sn for which experimental results are not available would have a lower free energy of mixing and expectedly a stronger tendency for compound formation than that observed in K-Pb. (author). 19 refs, 7 figs, 1 tab.

7544 (IC–93/276) **Identity for propagator in four-fermion theory.** Karnaukhov, S. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 4p. Order Number DE94611104. Source: OSTI; NTIS (US Sales Only); INIS.

The method of exact evaluation of quantum partition function (QPF) in some four fermion models is proposed. The calculations are carried out by the path integral method. The integral is evaluated by introducing the additional fields (called Hubbard-Stratanovich transformation in some models), integration over fermionic variables, and considering the finite-dimensional approximation of the rest integral over bosonic fields in the infinite limit. The non-standard representation of propagator is proposed for the Fermi-theory of four-fermion interaction. This representation seems to be more convenient for the nonperturbative analysis. (author). 7 refs.

7545 (KFKI–1993-10/G) **Effect of detector size and position on measured vibration spectra of strings and rods.** Lipcsei, S. (Atomic Energy Research Inst., Budapest (Hungary). Dept. of Applied Reactor Physics); Kiss, S.; Por, G. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. 17p. Order Number DE94611105. Source: OSTI; NTIS (US Sales Only); INIS.

Submitted to Progress in Nuclear Energy.

Weight functions of string and rod vibrations are described by standing and travelling wave models. The effects of detector size and position on the measured vibration spectra was investigated, and the main characteristics of the transfer function were calculated by a simple standing wave model. The theoretical results were compared with data from laboratory rod vibration experiments, and with pressure fluctuation spectra obtained at the Paks Nuclear Power Plant. In addition, some fundamental physical consequences can be made using the theory of superposition of travelling waves and their reflection on clamped rod ends. (R.P.) 5 refs.; 10 figs.

7546 (LA–12644-M) **TIPC user manual.** Kelley, T.A.; Roussel-Dupre, R.A.; Symbalisty, E.M.D.; Clodius, W.B. Los Alamos National Lab., NM (United States). Nov 1993. 52p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94004470. Source: OSTI; NTIS; GPO Dep.

The Translonospheric Propagation Code (TIPC) computer program executes tasks related to the detection of vhf and uhf signals following propagation through the ionosphere. These tasks include: transionospheric propagation, signal detection, signal processing, delta time of arrival study, delta time of arrival uncertainty study, and signal reconstruction. The parameters needed to accomplish each task are defined and the process of using TIPC in each of these tasks is explained step-by-step. TIPC is also capable of saving these parameter values defined for the specific task. In addition, subroutine descriptions are identified.

7547 (LAMP–93/3) **Three-photon micromasers.** Lamp Series Report (Laser, Atomic and Molecular Physics), Lamp Series Report (Laser, Atomic and Molecular Physics). Obada, A.S.F. (International Centre for Theoretical Physics, Trieste (Italy)); Abu Sitta, A.M.M.; Yasin, O.M. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 8p. Order Number DE94611106. Source: OSTI; NTIS (US Sales Only); INIS.

A non-degenerate 3-photon micromaser is analyzed. A 4-level atom is taken and 3 models of the field are considered. The model is solved for the case of resonance and the master equation for the density matrix is obtained. Semi-analytical solutions are obtained under specified approximations. Three modes can exist depending on the time of interaction. (author). 10 refs, 2 figs.

7548 (LA-UR–93-4173) **The status of the solar neutrino problem.** Bowles, T.J. Los Alamos National Lab., NM (United States). [1993]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9305309–1: 16. meeting on elementary particle physics, Kazimierz (Poland), 24-28 May 1993). Order Number DE94003934. Source: OSTI; NTIS; INIS; GPO Dep.

Perhaps the most outstanding discrepancy between prediction and measurements in current particle physics comes from the solar neutrino problem, in which a large deficit of high-energy solar neutrinos is observed. Many Nonstandard Solar Models have been invoked to try to reduce the predicted flux, but all have run into problems in trying to reproduce other measured parameters (e.g., the luminosity) of the Sun. Other explanations involving new physics such as neutrino decay and neutrino oscillations, etc. have also been proffered. Again, most of these explanations have been ruled out by either laboratory or astrophysical measurements. It appears that perhaps the most likely particle physics solution is that of matter enhanced neutrino oscillation, the Mikheyev-Smirnov-Wolfenstein (MSW) oscillations. Two new radiochemical gallium experiments, which have a low enough threshold to be sensitive to

the dominant flux of low-energy p-p neutrinos, now also report a deficit and also favor a particle physics solution. The next generation of solar experiments promise to finally resolve the source of the "solar neutrino problem" by the end of this decade.

7549 (LA-UR–93-4185) **A space-based classification system for RF transients.** Moore, K.R. (Los Alamos National Lab., NM (United States)); Call, D.; Johnson, S.; Payne, T.; Ford, W.; Spencer, K.; Wilkerson, J.F.; Baumgart, C. Los Alamos National Lab., NM (United States). [1993]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9309289–1: International workshop on artificial intelligence applications in solar-terrestrial physics, Lund (Sweden), 22-24 Sep 1993). Order Number DE94003933. Source: OSTI; NTIS; INIS; GPO Dep.

The FORTE (Fast On-Orbit Recording of Transient Events) small satellite is scheduled for launch in mid 1995. The mission is to measure and classify VHF (30–300 MHz) electromagnetic pulses, primarily due to lightning, within a high noise environment dominated by continuous wave carriers such as TV and FM stations. The FORTE Event Classifier will use specialized hardware to implement signal processing and neural network algorithms that perform onboard classification of RF transients and carriers. Lightning events will also be characterized with optical data telemetered to the ground. A primary mission science goal is to develop a comprehensive understanding of the correlation between the optical flash and the VHF emissions from lightning. By combining FORTE measurements with ground measurements and/or active transmitters, other science issues can be addressed. Examples include the correlation of global precipitation rates with lightning flash rates and location, the effects of large scale structures within the ionosphere (such as traveling ionospheric disturbances and horizontal gradients in the total electron content) on the propagation of broad bandwidth RF signals, and various areas of lightning physics. Event classification is a key feature of the FORTE mission. Neural networks are promising candidates for this application. The authors describe the proposed FORTE Event Classifier flight system, which consists of a commercially available digital signal processing board and a custom board, and discuss work on signal processing and neural network algorithms.

7550 (LA-UR–93-4262) **Acceleration in astrophysics.** Colgate, S.A. Los Alamos National Lab., NM (United States). [1993]. 21p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9308206–1: International workshop on acceleration and radiation generation in space and laboratory plasmas, Kardmall (Greece), 10 Aug - 4 sep 1993). Order Number DE94004986. Source: OSTI; NTIS; INIS; GPO Dep.

The origin of cosmic rays and applicable laboratory experiments are discussed. Some of the problems of shock acceleration for the production of cosmic rays are discussed in the context of astrophysical conditions. These are: The presumed unique explanation of the power law spectrum is shown instead to be a universal property of all lossy accelerators; the extraordinary isotropy of cosmic rays and the limited diffusion distances implied by supernova induced shock acceleration requires a more frequent and space-filling source than supernovae; the near perfect adiabaticity of strong hydromagnetic turbulence necessary for reflecting the accelerated particles each doubling in energy roughly 10^5 to ^{6} scatterings with negligible energy loss seems most unlikely; the evidence for acceleration due to quasi-parallel heliosphere shocks is weak. There is small evidence for the expected strong hydromagnetic turbulence, and instead, only a small number of particles accelerate after only a few shock traversals; the acceleration of electrons in the same collisionless shock that accelerates ions is difficult to reconcile with the theoretical picture of strong hydromagnetic turbulence that reflects the ions. The hydromagnetic turbulence will appear adiabatic to the electrons at their much higher Larmor frequency and so the electrons should not be scattered incoherently as they must be for acceleration. Therefore the electrons must be accelerated by a different mechanism. This is unsatisfactory, because wherever electrons are accelerated these sites, observed in radio emission, may accelerate ions more favorably. The acceleration is coherent provided the reconnection is coherent, in which case the total flux, as for example of collimated radio sources, predicts single charge accelerated energies much greater than observed.

7551 (LA-UR–93-4279) **BATSE burst location accuracy and constraints on the fraction of repeating GRB sources.** Strohmayer, T.E. (Los Alamos National Lab., NM (United States)); Fenimore, E.E.; Miralles, J.A. Los Alamos National Lab., NM (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9310252–2: BATSE gamma-ray burst workshop, Huntsville, AL (United States), 21-23 Oct 1993). Order Number DE94004981. Source: OSTI; NTIS; GPO Dep.

We use a one parameter model for GRB source repetition to investigate the ability of BATSE to detect source repetition and to place constraints on the fraction of repeating sources. From Monte Carlo simulations we find that the current uncertainty in BATSE burst locations severely limits our ability to confidently detect source repetition from distributions containing fewer than 10 – 15% repeaters. A fit of our repetition model to 260 BATSE catalog bursts yields a best-fit repeating fraction of f_r = 21% with a 90% confidence region ranging from 5.5 to 32.5%. By modifying the size of the measurement errors in our simulations we show that the location and width of the confidence region depends sensitively on the burst location errors. With BATSEs present location accuracy analysis of larger samples of bursts will not appreciably improve the constraint on the repeating fraction.

7552 (LA-UR–93-4313) **DMSP satellites as gamma-ray burst detectors.** Terrell, J. (Los Alamos National Lab., NM (United States)); Lee, P.; Klebesadel, R.W.; Griffee, J.W. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9310252–1: BATSE gamma-ray burst workshop, Huntsville, AL (United States), 21-23 Oct 1993). Order Number DE94004977. Source: OSTI; NTIS; GPO Dep.

Gamma-ray burst detectors are aboard three US Air Force Defense Meteorological Satellite Program (DMSP) spacecraft, in orbit at 800 km altitude, with corresponding fields of view to 117° from the zenith. A large number of bursts have been detected by DMSP, usually confirming and supplementing data from GRO and other spacecraft. The location of a gamma-ray burst source detected by several DMSP spacecraft is considerably restricted by knowledge of the several fields of view. Often non-detection of a strong burst by one or more DMSP spacecraft is even more informative in narrowing the possible area of the burst. The DMSP data in conjunction with observations by other spacecraft can lead to reasonable positional information when more accurate positions are not available from GRO or other data.

7553 (LA-UR–93-4340) **Gamma-ray bursts from the accretion of solid bodies onto high-velocity Galactic neutron stars.** Colgate, S.A.; Leonard, P.J.T. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by Department of Defense, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9310252–4: BATSE gamma-ray burst workshop, Huntsville, AL (United States), 21-23 Oct 1993). Order Number DE94005006. Source: OSTI; NTIS; GPO Dep.

We propose a simple model for the gamma-ray bursts based on high- velocity Galactic neutron stars that have accretion disks. The latter are formed from a mixture of material from the supernova shell and that ablated from a pre-supernova binary companion. Accretion onto the neutron star from this disk when the disk is still largely gaseous may result in a soft gamma-ray repeater phase. Much later, after the neutron star has moved away from its birthplace, solid bodies form in the disk, and some are perturbed into hitting the neutron star to create gamma-ray bursts. This model makes several predictions that are consistent with the observations. The observed combination of a high degree of isotropy on the sky coupled with the observed value of $< V/V_{max} >$ is not, at first glance, predicted, but is not impossible to attain in our model.

7554 (LA-UR–93-4397) **Production rates of terrestrial in-situ-produced cosmogenic nuclides.** Reedy, R.C. (Los Alamos

National Lab., NM (United States)); Tuniz, C.; Fink, D. Los Alamos National Lab., NM (United States). [1993]. 7p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-930960–7: 6. international conference on accelerator mass spectrometry, Canberra (Australia), 17 Sep - 1 oct 1993). Order Number DE94005156. Source: OSTI; NTIS; GPO Dep.

Production rates of cosmogenic nuclides made in situ in terrestrial samples and how they are applied to the interpretation of measured radionuclide concentrations were discussed at a one-day Workshop held 2 October 1993 in Sydney, Australia. The status of terrestrial in-situ studies using the long-lived radionuclides ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, and ^{41}Ca and of various modeling and related studies were presented. The relative uncertainties in the various factors that go into the interpretation of these terrestrial in-situ cosmogenic nuclides were discussed. The magnitudes of the errors for these factors were estimated and none dominated the final uncertainty.

7555 (LA-UR–93-4406) **Simulations of terrestrial in-situ cosmogenic-nuclide production.** Reedy, R.C. (Los Alamos National Lab., NM (United States)); Nishiizumi, K.; Arnold, J.R.; Lal, D.; Englert, P.A.J.; Klein, J.; Middleton, R.; Jull, A.J.T. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Deutsche Forschungsgemeinschaft, Bonn (Germany). DOE Contract W-7405-ENG-36. (CONF-930960–6: 6. international conference on accelerator mass spectrometry, Canberra (Australia), 17 Sep - 1 oct 1993). Order Number DE94004999. Source: OSTI; NTIS; GPO Dep.

Targets of silicon and silicon dioxide were irradiated with spallation neutrons to simulate the production of long-lived radionuclides in the surface of the earth. Gamma-ray spectroscopy was used to measure ^{7}Be and ^{22}Na, and accelerator mass spectrometry was used to measure ^{10}Be, ^{14}C, and ^{26}Al. The measured ratios of these nuclides are compared with calculated ratios and with ratios from other simulations and agree well with ratios inferred from terrestrial samples.

7556 (LBL–34783) **Equation of state of neutron star matter, limiting, rotational periods of fast pulsars, and the properties of strange stars.** Weber, F. (Technische Univ. Muenchen, Garching (Germany). Inst. fuer Theoretische Physik); Glendenning, N.K. Lawrence Berkeley Lab., CA (United States). 25 Oct 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-930999–4: NATO Advanced Study Institute on hot and dense nuclear matter, Bodrum (Turkey), 26 Sep - 9 oct 1993). Order Number DE94005214. Source: OSTI; NTIS; INIS; GPO Dep.

In this paper the following items will be treated: The present status of dense nuclear matter calculations and constraints on the behavior of the associated equation of state at high densities from data on rapidly rotating pulsars. Recent finding of the likely existence of a mixed phase of baryons and quarks forming a coulomb lattice in the dense cores of neutron stars. Review of important findings of recently performed calculations of rapidly rotating compact stars. These are constructed in the framework of general relativity theory for a representative collection of realistic nuclear equations of state. Establish the minimum-possible rotational periods of gravitationally bound neutron stars and self-bound strange stars. Its knowledge is of fundamental importance for the decision between pulsars that can be understood as rotating neutron stars and those that cannot (signature of hypothetical self-bound matter of which strange stars are the likely stellar candidates. Investigate the properties of sequences of strange stars. Specifically, we answer the question whether such objects can give rise to the observed phenomena of pulsar glitches, which is at the present time the only astrophysical test of the strange-quark-matter hypothesis.

7557 (NIIYaF-MGU–92-9-258) **Study on the precipitations of high-energy charged particles in the Brazilian anomaly region.** Gusev, A.A.; Pugacheva, G.I.; Bui Van', N.A.; Martin, I.M. Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1992. 17p. (In Russian). Order Number DE94610505. Source: OSTI; NTIS (US Sales Only); INIS.

Geomagnetic conditions are analyzed when carrying out measurements at the Campinas balloon shoting-range in the region of the Brazilian magnetic anomaly. It is shown that in the region takes place gradual lowering in time of the L shells. The conclusion is made on the radial particle diffusion as the most probable cause of observed in the region particle precipitation in the upper layers of atmosphere. An instrument is described for balloon investigations of particle precipitations. The instrument permits to determine the kind of the particles and to measure their energy. Preliminary results of measurements of the hight dependences of secondary electrons and protons are presented. 6 refs.; 7 figs.; 2 tabs.

7558 (NIIYaF-MGU–92-31-280) **Global changes of radiation situation at heights <1000 km.** Gusev, A.A.; Pugacheva, G.I.; Mineev, Yu.V.; Tolstaya, E.D. Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1992. 24p. (In Russian). Order Number DE94610504. Source: OSTI; NTIS (US Sales Only); INIS.

On the base of satellite measurements in the 21- and 22-th solar cycles is developed a model of the electron component of the Earth radiation belts. Spatial electron distributions are obtained at 350, 500 and 800 km in the minimum and maximum of the solar cycle. Global changes are noted in the spatial radiation distribution near the Earth in comparison with 1965-1972, namely decreasing trapped electron fluxes and increasing quasi-trapped oned at small heights and variations in the spectrum in the region of the inner radiation belt. A model of trapped protons is developed which permits to precise flux forecasting owing to corrections accounting for Earth magnetic moment decreasing and atmospheric cutting off. 13 refs.; 2 figs.; 5 tabs.

7559 (UCRL-JC–115684) **Two dimensional self-consistent fluid simulation of rf inductive sources.** DiPeso, G.; Vahedi, V.; Hewett, D.W.; Rognlien, T.D. Lawrence Livermore National Lab., CA (United States). 17 Nov 1993. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9311104–13: 40. national symposium of the American Vacuum Society (AVS), Orlando, FL (United States), 15-19 Nov 1993). Order Number DE94003635. Source: OSTI; NTIS; GPO Dep.

The two-dimensional (R - Z) electromagnetic code FMRZ has been written to model inductive sources self-consistently in time. The code models an argon plasma with momentum-transfer, excitation and ionization as electron-neutral reactions and scattering and charge-exchange for the ion-neutral reactions. The electrons and ions are treated as Maxwellian fluid species and a reduced set of Maxwell's equations is used to advance the electromagnetic fields. The set of equations used in FMRZ is not subject to typical numerical constraints present in many time dynamic codes allowing one to choose appropriate the and space scales to resolve only the frequencies and scale lengths of interest. The model retains nonlinear driving terms which give rise to a pondermotive force that distorts the density profile. Density and power profiles will be used to illustrate the physical effects of various terms in the equations. Trends in average density and temperature compare well with an analytic model.

7560 (UCRL-JC–115702) **Equation of state of stellar plasmas.** Rogers, F.J. Lawrence Livermore National Lab., CA (United States). Jun 1993. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9306287–1: Equation of state in astrophysics workshop, Saint-Malo (France), 14-18 Jun 1993). Order Number DE94004186. Source: OSTI; NTIS; GPO Dep.

The equation of state (EOS) of astrophysical plasmas is, for a wide range of stars, nearly ideal; with only small non-ideal Coulomb corrections. Calculating the EOS of an ionizing plasma from a ground state ion, ideal gas model is easy, whereas, fundamental methods to include the small Coulomb corrections are difficult. Attempts to include excited bound states are also complicated by plasma screening and microfield phenomena that weaken and broaden these states. Nevertheless, the high quality of current observational data, particularly seismic, dictates that the best possible models should be used. The present article discusses these issues and describes how they are resolved by fundamental many-body quantum statistical methods. Particular emphasis is placed on

the activity expansion method that is the basis of the OPAL opacity code. Some comparisons with standard methods are given.

6620 Physics of Elementary Particles and Fields

7561 (BNL–52389) **Future directions in particle and nuclear physics at multi-GeV hadron beam facilities.** Geesaman, D.F. (Argonne National Lab., IL (United States)). Brookhaven National Lab., Upton, NY (United States). [1993]. 618p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-930389–: Future directions in particle and nuclear physics at multi-GeV hadron beam facilities, Upton, NY (United States), 4-6 Mar 1993). Order Number DE94002946. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains papers on the following topics in particle and nuclear physics: hadron dynamics; lepton physics; spin physics; hadron and nuclear spectroscopy; hadronic weak interactions; and Eta physics. These papers have been indexed separately elsewhere.

7562 (DOE/ER–0607T) **US/Japan Cooperation in High Energy Physics: Review of activities, 1988–1993.** USDOE Office of Energy Research, Washington, DC (United States). Office of High Energy and Nuclear Physics. 16 Nov 1993. 148p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94005376. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of the Implementing Arrangement was to further the energy programs of both countries by establishing a framework for cooperation in the field of high energy physics, including research, accelerator and detector instrumentation research and development, the fabrication and subsequent use of new experimental devices and facilities, and related joint efforts as may be mutually agreed. Over the years, this cooperation has been very effective and has strengthened the overall collaborative efforts and the understanding between our nations and their citizens. It has demonstrated to the world our ability to work together to attack difficult problems. High Energy Physics goes across national borders; the bond is clearly intellectual and common ground is shared for the benefit of all in a most effective manner. This review covers the activities conducted under the aegis of the US/Japan Committee for Cooperation in High Energy Physics during the past five years (1988–1993). This was the second such US review of the US/Japan cooperative activities; the first was held in 1987.

7563 (DOE/ER/40272–194) **Task A: Research in theoretical elementary particle physics at the University of Florida: Annual progress report.** Field, R.D.; Ramond, P.M.; Sikivie, P.; Thorn, C.B. Florida Univ., Gainesville, FL (United States). Inst. for Fundamental Theory. 1 Nov 1993. 100p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-86ER40272. (UFIFT-HEP–93-24). Order Number DE94004373. Source: OSTI; NTIS; INIS; GPO Dep.

This is the Annual Progress Report of the theoretical particle theory group at the University of Florida under DoE Grant DE-FG05-86ER40272. At present our group consists of four Full Professors (Field, Ramond, Thorn, Sikivie) and three Assistant Professors (Qiu, Woodard, Kennedy). Dallas Kennedy recently joined our group increasing the Particle Theory faculty to seven. In addition, we have three postdoctoral research associates, an SSC fellow, and eight graduate students. The research of our group covers a broad range of topics in theoretical high energy physics with balance between theory and phenomenology. Included in this report is a summary of the last several years of operation of the group and an outline of our current research program.

7564 (DOE/ER/40448–6) **[Electroweak and other interactions in medium-energy nuclear physics]: Progress report.** Mukhopadhyay, N.C. Rensselaer Polytechnic Inst., Troy, NY (United States). Dept. of Physics. [1993]. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER40448. Order Number DE94004161. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the following topics: spectrum generating algebra; vibrational spectra in the heavy quarkonia; chiral soliton model; pion neutral photoproduction from proton with polarized photons in the delta-1232 region; compton scattering in the delta-1232 region; nucleon magnetic polarizability and the role of the delta resonance; eta photo- and electroproduction; perturbative QCD; and nuclear muon capture.

7565 (DOE/ER/40627–3) **Elementary particle interactions: Progress report, October 1, 1992–September 30, 1993.** Bugg, W.M.; Condo, G.T.; Handler, T.; Hart, E.L.; Read, K.; Ward, B.F.L. Tennessee Univ., Knoxville, TN (United States). Dept. of Physics and Astronomy. Oct 1993. 124p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-91ER40627. Order Number DE94004238. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses: Fermilab E782-E745; GEM; L3 Experiment; Fixed Target Photoproduction; SLD; E144 at SLAC and; Silicon Detectors - Radiation Hardness Program.

7566 (DOE/ER/40661–5) **Indiana University High Energy Physics, Task A: Technical progress report, 1992–1993.** Brabson, B. (and others); Crittenden, R.; Dzierba, A. Indiana Univ., Bloomington, IN (United States). Dept. of Physics. [1993]. 110p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER40661. Order Number DE94000961. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses research at Indians University on the following high energy physics experiments: A search for mesons with unusual quantum numbers; hadronic states produced in association with high-mass dimuons; FNAL E740 (D0); superconducting super collider; and OPAL experiment at CERN.

7567 (DOE/ER/40665–T2) **Duke University High Energy Physics: Progress report, December 1, 1990–March 15, 1993.** Fortney, L.R.; Goshaw, A.T.; Walker, W.D. Duke Univ., Durham, NC (United States). High Energy Physics Group. Mar 1993. 230p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-91ER40665. Order Number DE94004407. Source: OSTI; NTIS; INIS; GPO Dep.

The research program of the Duke High Energy Physics Group is described in this Progress Report and a separate Proposal containing their plans for 1994. These two documents are supplemented by compilations of selected publications, thesis abstracts, and the curriculum vitae of the eleven Ph.D. physicists who are carrying out this research program. This Progress Report contains a review of the research which has been done over the first half (1992 and 1993 to date) of the current three-year DOE grant, plus some earlier research to establish a broader perspective of the research interests. High energy physics research at Duke has three components. The first, Task A, is based upon experiments carried out at Fermilab's Tevatron Collider. The group is finishing the analysis of data from their first collider experiment (E735), a study of inclusive particle production from $\bar{p}$ p collisions at $\sqrt{s}$ = 1.8 TeV. The second component of the research, Task B, deals primarily with heavy flavor physics. The third part of the research program, Task D, deals with preparation for research at the SSC. The authors have been active in the development of tracking detectors for the SSC since 1989, and are now concentrating on the design and construction of straw tube drift chambers for the solenoid detector.

7568 (DOE/ER/40677–2-Pt.1) **Research on elementary particle physics, Task P: Studies in theory and phenomenology of elementary physics: Annual progress report, November 1, 1992–October 31, 1992: Part 1.** Holloway, L.E.; O'Halloran, T.A. Illinois Univ., Urbana, IL (United States). Loomis Lab. of Physics. May 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER40677. Order Number DE94004955. Source: OSTI; NTIS; INIS; GPO Dep.

Continued progress has been made in isolating the variables needed to completely specify a quark or gluon jet, independent of the process in which it is created. We have evidence of a slow, but statistically significant, dependence on the sub-energy of the hard process in which the jet arises. Once this is taken into account, jets from e^+e^- are consistent with those created in $p\bar{p}$. Neural network jet identification studies win be based on this expanded set of variables. Work on the new type of Dirac equation for a relativistic oscillator was presented at the International Conference on High Energy Physics in Dallas, and will be published in the Proceedings of the Conference. Theoretical studies involving jet signals for

theoretically predicted (but as yet undiscovered) particles are underway.

7569 (DOE/ER/40677–2-Pt.2) **Research on elementary particle physics: Part 2: Annual progress report, November 1, 1992–October 31, 1993.** Holloway, L.E. Illinois Univ., Urbana, IL (United States). Loomis Lab. of Physics. May 1993. 57p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER40677. Order Number DE94004956. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes the activities of the University of Illinois Experimental High Energy Physics Group. The physicists in the University of Illinois High Energy Physics Group are engaged in a wide variety of experiments at current and future accelerator laboratories. These include: (1) The CDF experiment at the Fermilab Tevetron $p\bar{p}$ collider. (2) Design and developmental work for the SDC group at SSCL. (3) Experiments at the wide band photon beam at Fermilab. (4) e^+e^- experiments, the Mark III and SLD at SLAC and CLEO at Cornell. (5) CP violation experiments at Fermilab. (6) The HiRes cosmic ray experiment at Dugway Proving Grounds, Utah. (7) Computational facilities. (8) Electronics systems development.

7570 (FNAL/C–93/282) **Panel session: Part 1, In flux – Science Policy and the social structure of Big Laboratories, 1964–1979.** Westfall, C. (Michigan State Univ., East Lansing, MI (United States)). Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1993. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9206131–5: 3. international symposium on the history of particle physics - the rise of the standard model, Stanford, CA (United States), 24-27 Jun 1992). Order Number DE94002303. Source: OSTI; NTIS; GPO Dep.

This report discusses the in flux of science policy and the social structure of big laboratories during the period of 1964 to 1979 and some sociological consequences of high energy physicists' development of the standard model during the same period.

6621 General Theory of Particles and Fields

Refer also to citation(s) 7311, 7536, 7601

7571 (BONN-HE–93-10) **New supersymmetrizations of the generalized KDV hierarchies.** Figueroa-O'Farrill, J.M.; Stanciu, S. Bonn Univ. (Germany). Physikalisches Inst. Mar 1993. 12p. (HEP-TH–9303168). Order Number DE94734004. Source: OSTI; NTIS (US Sales Only); INIS.

Recently we investigated a new supersymmetrization procedure for the KdV hierarchy inspired in some recent work on supersymmetric matrix models. We extend this procedure here for the generalized KdV hierarchies. The resulting supersymmetric hierarchies are generically nonlocal, expect for the case of Boussinesque which we treat in detail. The resulting supersymmetric hierarchy is integrable and bihamiltonian and contains the Boussinesque hierarchy as a subhierarchy. In a particular realization, we extend it by defining supersymmetric odd flows. We end with some comments on a slight modification of this supersymmetrization which yields local equations for any generalized KdV hierarchy. (orig.)

7572 (BONN-HE–93-11) **Naked singularities in four-dimensional string backgrounds.** Mohammedi, N. Bonn Univ. (Germany). Physikalisches Inst. Apr 1993. 16p. (HEP-TH–9304013). Order Number DE94733996. Source: OSTI; NTIS (US Sales Only); INIS.

It is shown that gauged nonlinear sigma models can be always deformed by terms proportional to the field strength of the gauge fields (nonminimal gauging). These deformations can be interpreted as perturbations, by marginal operators, of conformal coset models. When applied to the SL(2, R)xSU(2)/U(1)xU(1) WZWN model, a large class of four-dimensional curved spacetime backgrounds are obtained. In particular, a naked singularity may form at a time when the volume of the universe is different from zero. (orig.)

7573 (DESY–93-051) **A monopole solution in open string theory.** Behrndt, K. Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). Inst. fuer Hochenergiephysik. Mar 1993. 16p. (HEP-TH–9304096). Order Number DE94734103. Source: OSTI; NTIS (US Sales Only); INIS.

We investigate a solution of the Weyl invariance conditions in open string theory in 4 dimensions. In the closed string sector this solution is a combination of the SU(2) Wess-Zumino-Witten model and a Liouville theory. The investigation is carried out in the σ model approach where we have coupled all massless modes (especially and abelina gauge field via the boundary) and tachyon fields. Neglecting all higher derivatives in the field strength we get an exact result which can be interpreted as a monopole configuration living in non-trivial space time. The masses of both tachyon fields are quantized by c_{wzw} and vanish for $c_{wzw} = 1$. (orig.)

7574 (IC–93/188) **On quantization of time-dependent systems with constraints.** Hadjialieva, F.G. (Azerbaijan State Pedagogical Univ., Baku (Azerbaijan)); Jafarov, R.G. International Centre for Theoretical Physics, Trieste (Italy). Jul 1993. 7p. Order Number DE94611114. Source: OSTI; NTIS (US Sales Only); INIS.

The Dirac method of canonical quantization of theories with second class constraints has to be modified if the constraints depend on time explicitly. A solution of the problem was given by Gitman and Tyutin. In the present work we propose an independent way to derive the rules of quantization for these systems, starting from physical equivalent theory with trivial nonstationarity. (author). 4 refs.

7575 (IC–93/211) **N = 4 supersymmetry from the quantum affine algebra U_q(A-circumflex$^{(1)}_3$).** EL Hassouni, A. (Laboratory of Theoretical Physics, Rabat (Morocco). Faculte des Sciences de Rabat); Hassouni, Y.; Zakkari, M. International Centre for Theoretical Physics, Trieste (Italy). Jul 1993. 9p. Order Number DE94611145. Source: OSTI; NTIS (US Sales Only); INIS.

The quantized algebra U_q(A-circumflex$^{(1)}_3$) is analysed. It is shown that the U_q(A-circumflex$^{(1)}_3$) and N = 4 SUSY algebras have many similarities for special values of q, namely $q^{2\alpha} = -1$ where α is a continuous parameter. Moreover, U_q(A-circumflex$^{(1)}_3$) can be endowed with at most three independent spectral parameter Hopf structures. The adjoint action of U_q(A-circumflex$^{(1)}_3$) is given. (author). 10 refs.

7576 (IS-T–1684) **Topics in electroweak baryogenesis: The sphaleron and t-violation.** SeungKoog, L. Ames Lab., IA (United States). 7 Dec 1993. 121p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94004886. Source: OSTI; NTIS; INIS; GPO Dep.

Assuming that beyond the standard model physics can be parametrized in terms of high dimensional operators, we examine their effects on the energy of the sphaleron and the classical solution of the gauge and Higgs fields. In the absence of fermions, all of the six dimension 6 operators which are SU(2) symmetric have a small effect when calculated perturbatively. However, calculated non-perturbatively, one of the operators alters the boundary conditions of the equations of motion of the Higgs and gauge fields involved, and another operator gives rise to an abrupt change in the sphaleron energy at a small but definite Higgs quartic coupling. The magnitude of the T-violating muon polarization induced by electromagnetic final state interaction in the radiative Kaon decay $K^+ \rightarrow \mu^+\nu\mu\gamma$ is order of 10^{-3}.

7577 (JINR-E–2-92-107) **On a connection between the Yang-Mills equations in dimension greater than four and the classical Yang-Baxter equations.** Ivanova, T.A.; Popov, A.D. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 16p. Order Number DE94611115. Source: OSTI; NTIS (US Sales Only); INIS.

We consider the Yang-Mills equations for gauge fields of an arbitrary semisimple Lie group G in Euclidean spaces R^{11} with dimension n>4. 21 refs.

7578 (JINR-E–2-92-168) **About G-parity violation in $\tau^- \rightarrow \nu\pi\eta$ decay.** Bednyakov, V.A. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Nuclear Problems. 1992. 8p. Order Number DE94611146. Source: OSTI; NTIS (US Sales Only); INIS.

The characteristics of the G-parity forbidden $\tau \to \nu\pi\eta$ decay were calculated in the phenomenological quark model with allowance for isospin symmetry violation. 10 refs.; 2 tabs.

7579 (JINR-E-2-92-172) **String-like excitations in QED.** Fursaev, D.V. (Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics); Shabanov, S.V.; Prokhorov, L.V. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 8p. Order Number DE94611116. Source: OSTI; NTIS (US Sales Only); INIS.

The evolution of string-like excitations of fields (exponential line integrals) in free QED and in QED with static sources is investigated. 9 refs.

7580 (JINR-E-2-92-176) **Phase transition in $g\Phi_2^4$ theory.** Ganbold, G.; Efimov, G.V. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 12p. Order Number DE94611117. Source: OSTI; NTIS (US Sales Only); INIS.

The vacuum stability of a scalar $g\Phi$ theory in two-dimension is studied. It is in complete agreement with the Simon-Griffiths theorem. 18 refs.

7581 (JINR-E-2-92-191) **Effective potential in $g\phi_2^4$ theory.** Ganbold, G.; Efimov, G.V. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 10p. Order Number DE94611118. Source: OSTI; NTIS (US Sales Only); INIS.

The scalar ϕ_2^4 theory is studied. A leading term of the effective potential and corrections to it are obtained. A second-order phase transition which is in agreement with the existing results is observed. 14 refs.; 1 fig.

7582 (JINR-E-2-92-195) **On a complex vacuum structure in non-abelian gauge theories and on the place of Majorana particles in these theories.** Beshtoev, Kh.M. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 7p. Order Number DE94611147. Source: OSTI; NTIS (US Sales Only); INIS.

It is shown that a complex vacuum structure is impossible in SU(N) gauge theories. The complex vacuum structure in extended theories with complec vector fields. It is shown that Majorana particles cannot exist in standard SU(N) gauge-invariant theories. 7 refs.

7583 (JINR-E-2-92-502) **Local symmetries in systems with constraints.** Gogilidze, S.A.; Sanadze, V.V.; Surovtsev, Yu.S.; Tkebuchava, F.G. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 16p. Order Number DE94611148. Source: OSTI; NTIS (US Sales Only); INIS.

For arbitrary systems with first-class constraints a method is given for constructing local gauge tranformations in accordance with the Dirac hypothesis in phase and configuration spaces. 19 refs.

7584 (JINR-E-2-92-538) **Infrared troubles of differential renormalization.** Avdeev, L.V.; Kazakov, D.I.; Kondrashuk, I.N. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 24p. Order Number DE94611119. Source: OSTI; NTIS (US Sales Only); INIS.

The possibility of generalizing differential renormalization of D.Z. Freedman, K.Jonnson and J.I.Latorre in an invariant fashion to theories with infrared divergencies is investigated. It is concluded that the calculations on infrared differential renormalization lead to incorrect result. 16 refs.; 7 figs.

7585 (JINR-R-2-92-505) **Doppler effect for electron and Lorentz transfomations in special relativity theory.** Klenin, B.A. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Nuclear Reactions. 1992. 10p. (In Russian). Order Number DE94611111. Source: OSTI; NTIS (US Sales Only); INIS.

It is shown that in the electromagnetic field of vacuum the electron possesses the wave motion, frequency of which is equal to the Doppler frequency. On this basis the Lorentz transformations for coordinates and time of the special relativity theory are obtained. 7 refs.

7586 (JINR-R-4-92-367) **Supersymmetry, geometric nonadiabatic phases, exact solutions in diatomic systems.** Suz'ko, A.A. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 23p. (In Russian). Order Number DE94611149. Source: OSTI; NTIS (US Sales Only); INIS.

It is shown that the nonadiabatic geometric phases are generalized in addition to the Aharonov - Anandan ones. 32 refs.

7587 (JINR-R-13-92-551) **Frequency method estimate of the pulse transient characteristic of power feedback in the IBR-2 reactor.** Popov, A.K. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Nuclear Problems. 1992. 8p. (In Russian). Order Number DE94611120. Source: OSTI; NTIS (US Sales Only); INIS.

The IBR-2 pulsed reactor power feedback parameters are estimated by means pf the frequency analysis of recorded power oscillations caused by reactivity jump oscillations. 1 ref.; 4 figs.

7588 (KFKI-1993-08/A) **Z(2N) parafermions from U(1) loop group.** Boehm, G.; Szlachanyi, K. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. 17p. Order Number DE94611112. Source: OSTI; NTIS (US Sales Only); INIS.

The concept of the loop group describes a conformal model in terms of bounded operators. The simplest possibility, the central extended U(1) loop group algebra spanned by operators W(f), $f:S^1 \to R$ satisfying Weyl algebra relations is considered. The possibility that the loop group element e^{if} represented by W(f) does not necessarily lie in the identity component is investigated. This leads to a quantization of the level parameter k in the cocycle. Considering this 'large' loop group algebra as the algebra of observables, their Z_k type of superselection sectors is studied, and fields are constructed that create the Z_k charges. The commutation relations of these fields turn out to be of the parafermion type. (K.A.) 4 refs.

7589 (LAPP-AL-391-92) **W-algebras and superalgebras from constrained WZW models: A group theoretical classification.** Frappat, L.; Ragoucy, E.; Sorba, P. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Jul 1992. 67p. Order Number DE94611121. Source: OSTI; NTIS (US Sales Only); INIS.

A classification of W algebras and superalgebras arising in Abelian as well as non Abelian Toda theories is presented. Each model, obtained from a constrained WZW action, is related with an Sl(2) subalgebra (resp. OSp(1/2) superalgebra) of a simple Lie algebra (resp. superalgebra) G. However, the determination of an $U(1)_Y$ factor, commuting with Sl(2) (resp. OSp(1/2)), appears, when it exists, particularly useful to characterize the corresponding W algebra. The (super) conformal spin contents of each W (super)algebra is performed. The class of all the superconformal algebras (i.e. with conformal spins $s \leq 2$) is easily obtained as a byproduct of our general results. (author) 26 refs.; 21 tabs.

7590 (LAPP-AL-404-92) **Deformation of the strange superalgebra P-tilde(n).** Frappat, L. (Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires); Sorba, P.; Sciarrino, A. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Oct 1992. 7p. Contract CEE SC 1000221. Order Number DE94611122. Source: OSTI; NTIS (US Sales Only); INIS.

A deformation $U_q(\text{P-tilde}(n))=\text{P-tilde}_q(n)$ of the extended non contragredient (strange) superalgebra of P(n), denoted by P-tilde(n), is proposed. A realization of $\text{P-tilde}_q(n)$ in terms of q-bosons and q-fermions is presented. Then a procedure to build up a set of representations of $\text{P-tilde}_q(n)$ is briefly discussed. As a by-product, a new realization of $SU_q(n)$ is obtained. (author) 7 refs.

7591 (LAPP-AL-408-92) **Folding the W-algebras.** Frappat, L.; Ragoucy, E.; Sorba, P. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Nov 1992. 28p. Order Number DE94611123. Source: OSTI; NTIS (US Sales Only); INIS.

The folding of the Dynkin diagram of A_{2n} (resp., A_{2n-1}) produces the B_n (resp., C_n) Dynkin diagram, similarly the symmetry algebra W of a Toda model based on B_n (resp., C_n) can be seen as resulting from the folding of a W-algebra based on A_{2n} (resp., A_{2n-1}). More generally, W algebras related to the B-C-D algebra series can appear from W algebras related to the unitary ones. Such an

approach is particularly well adapted to obtain fusion rules of W algebras based on non simply laced algebras from fusion rules corresponding to the A_n case. Analogously, super-W algebras associated to orthosymplectic superalgebras are deduced from those relative to the unitary A(m,n) series. (author) 16 refs.; 1 tab.

7592 (LA-UR–93-3920) **Data on parity violation in the compound nucleus and its interpretation.** Bowman, J.D. (Los Alamos National Lab., NM (United States)); Frankle, C.M.; Knudson, J.N. TRIPLE Collaboration. Los Alamos National Lab., NM (United States); North Carolina State Univ., Raleigh, NC (United States); Duke Univ., Durham, NC (United States). [1993]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36 ; FG05-88ER40441 ; FG05-91ER40619. (CONF-9305235–5: International workshop/time reversal invariance and parity violation in neutron physics, Dubna (Russian Federation), 4-7 May 1993). Order Number DE94003965. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the measurement of parity-violating asymmetries in the compound nucleus; summary of data on this process; theories of the random asymmetry, M^2; and theories of the constant asymmetry.

7593 (LA-UR–93-4315) **(j,0)⊕(0,j) representation space: Dirac-like construct.** Ahluwalia, D.V.; Johnson, M.B.; Goldman, T. Los Alamos National Lab., NM (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9309304–2: 17. International School of Theoretical Physics meeting on standard model and beyond, Krakow (Poland), Sep 1993). Order Number DE94005011. Source: OSTI; NTIS; INIS; GPO Dep.

This is first of the two invited lectures presented at the "XVII International School of Theoretical Physics: Standard Model and Beyond 1993." The text is essentially based on a recent publication by the present authors. Here we show that the Dirac-like construct in the (j,0)⊕(0,j) representation space support a Bargmann-Wightman-Wigner type quantum field theory.

6622 Specific Theories and Interaction Models; Particle Systematics

Refer also to citation(s) 7311, 7579, 7646, 7664, 7667, 7690, 7720, 7721, 7722

7594 (ANL-HEP-CP–93-98) **Quenched QCD spectrum on a $32^3 \times 64$ lattice.** Kim, S.; Sinclair, D.K. Argonne National Lab., IL (United States). Nov 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310250–1: LATTICE 93: international symposium on lattice field theory, Dallas, TX (United States), 12-17 Oct 1993). Order Number DE94004623. Source: OSTI; NTIS; INIS; GPO Dep.

We present light hadron masses calculated from quenched QCD on a $32^3 \times 64$ lattice, using staggered quark sources of masses, $m_q a$ = 0.01,0.005 and 0.0025. Results from β = 6. 0(preliminary) and those from β = 6.5 are compared. Using $m_p(m_q = 0)$ and f_π, we suggest that β = 6.5 is in the asymptotic scaling region and β = 6.0 result shows ~ 20% (bare coupling) or ~ 10% (improved coupling) scaling violation. Flavor symmetry appears to be restored at β = 6.5. The estimated pion decay constant, f_π, is 93(4) MeV at β = 6.5, where the experimental value is 93 MeV.

7595 (BUDKERINP–92-57) **Logarithmic corrections of the two-body QED problem.** Khriplovich, I.B.; Mil'shtejn, A.I.; Elkhovskij, A.S. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1992. 27p. (IYaF–92-57.). Order Number DE94611157. Source: OSTI; NTIS (US Sales Only); INIS.

The logarithmic part of the Lamb shift, the contribution of the relative order $\alpha^3\log(1/\alpha)$ to the atomic state energy, is related to the usual infrared divergence. For positronium, the calculated logarithmic correction does not vanish only in n^3S_1 states and constitutes $5/24m\alpha^6\log(1/\alpha)/m^3$. Logarithmic corrections of the relative order $\alpha^2\log(1/\alpha)$ to the positronium decay rate are also of the relativistic origin and can be easily computed within the same approach. 31 refs.; 11 figs.

7596 (CONF-9201167–Summ.) **Heavy quark symmetry: Theory and applications.** Isgur, N. (Southeastern Universities Research Association, Inc., Newport News, VA (United States). Continuous Electron Beam Accelerator Facility). California Univ., Santa Barbara, CA (United States). Inst. for Theoretical Physics. 30 Jul 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG03-92ER40707. From Workshop on heavy quark symmetry: theory and applications; Santa Barbara, CA (United States); 13-31 Jan 1992. Order Number DE94003559. Source: OSTI; NTIS; INIS; GPO Dep.

This report very briefly discusses heavy quark symmetry.

7597 (DOE/ER/40291–20) **Asymptotic coherence of gluons and of q-bosons.** Nelson, C.A. State Univ. of New York, Binghamton, NY (United States). Dept. of Physics. [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER40291. (CONF-9306140–2: Coherent states: past present and future, Oak Ridge, TN (United States), 14-17 Jun 1993). Order Number DE94005417. Source: OSTI; NTIS; INIS; GPO Dep.

In theoretical physics one of the most important aspects of coherent states is that they can often be simply and reliably used to investigate the quantum coherence and correlation properties of new dynamical, quantum field theories. First, this paper reviews the coherent/degenerate state treatment of the infra-red dynamics of perturbative QCD. This based on the asymptotic behavior of the Hamiltonian operator as $|t| \to \infty$ in the interaction representation. Second, the paper reviews the usage of q-analogue coherent states $|z>_q$ to deduce coherence and uncertainty properties of the q-analogue quantized radiation field in the $|z>_q$ "classical limit" where $|z|$ is large. Third, for future applications, a new "projector" definition of the usual coherent states and of the squeezed states is reported.

7598 (DOE/ER/40412–T3) **The study of hadronic matter at the highest energy density: The search for the deconfined quark-gluon phase using 2 TeV p-p Collisions: Progress report, January 1, 1989–December 31, 1989.** Scharenbert, R.; Hirsch, A. Purdue Univ., Lafayette, IN (United States). Dept. of Physics. Dec 1989. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER40412. Order Number DE94004409. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses: running E-735, 1988–1989; publications from the 1987–1988 of E-735; exclusive nuclear fragmentation experiment at the Bevelac using the new TPC; research and development on parallel plate avalanche detectors; and data analysis.

7599 (DOE/ER/40427–20-N93) **The nucleon-nucleon potential in the chromodielectric soliton model.** Koepf, W. (Washington Univ., Seattle, WA (United States). Dept. of Physics); Wilets, L.; Pepin, S.; Stancu, F. Washington Univ., Seattle, WA (United States). Dept. of Physics. [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-88ER40427. (CONF-9309302–1: Conference on many-body physics, Coimbra (Portugal), 20-25 Sep 1993). Order Number DE94004646. Source: OSTI; NTIS; INIS; GPO Dep.

The short- and medium-range parts of the nucleon-nucleon interaction are being studied in the framework of the chromodielectric soliton model. The model consists of current quarks, gluons in the abelian approximation, and a scalar σ field which simulates the nonabelian interactions of the gluons and governs the medium through the dielectric function $\kappa(\sigma)$. Absolute color confinement is effected by the vanishing of the dielectric in vacuum; this also removes the troublesome van der Waals problem. The authors distinguish between spatial confinement, which arises from the self energy of the quarks in medium (excluding MFA contributions), and color confinement which is effected through OGE in the MFA (including the corresponding self energy contributions). The static (adiabatic) energies are computed as a function of deformation (generalized bag separation) in a constrained MFA. Six quark molecular-type wave functions in all important space-spin-isospin-color configurations are included. The gluon propagator is solved in the deformed dielectric medium. The resultant Hamiltonian matrix is diagonalized. Dynamics are handled in the Generator Coordinate Method, which leads to the Hill-Wheeler integral equation. In the present case, this yields a set of coupled equations corresponding

to the various configurations. Although this can be approximated by a set of differential equations, they propose to solve the integral equations with some regularization scheme.

7600 (DOE/ER/40427–21-N93) **Collapse of flux tubes.** Wilets, L. Washington Univ., Seattle, WA (United States). Dept. of Physics. [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-88ER40427. (CONF-930999–3: NATO Advanced Study Institute on hot and dense nuclear matter, Bodrum (Turkey), 26 Sep - 9 oct 1993). Order Number DE94004645. Source: OSTI; NTIS; INIS; GPO Dep.

Flux tubes are one of the most elementary systems of quantum chromodynamics. They are the idealized configurations of heavy quark-antiquark pairs at large separations L such that the region between can be assumed to possess axial-cylindrical symmetry. They play a central role in lattice QCD calculations and in models of QCD, as well as in the phenomenology of QCD processes. Lattice QCD calculations on flux tubes are generally limited to the quenched approximation (no massless quarks) and allow for a separation of the heavy quark-antiquark of only about 1 fm. Static flux tubes are unstable at separations greater than 1 fm, since the energy required to stretch the tube by 1 fm is about 1 GeV and that is about the energy difference between a quarkonium, $Q\bar{Q}$, and a pair of heavy-light mesons, $Q\bar{q} + \bar{Q}q$. Lattice calculations without light quarks cannot explore this instability. The author then reviews work on efforts to explore the creation of light quark pairs as a mechanism for flux tube breaking.

7601 (DOE/ER/40592–3) **Quantum Chromodynamics and nuclear physics at extreme energy density: Progress report, May 1992–April 1993.** Mueller, B. Duke Univ., Durham, NC (United States). Dept. of Physics. 15 May 1993. 56p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-90ER40592. Order Number DE94004418. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses research in the following topics: Hadron structure physics; relativistic heavy ion collisions; finite- temperature QCD; real-time lattice gauge theory; and studies in quantum field theory.

7602 (IC–93/200) **Anomaly cancellation in a class of chiral flavor gauge models.** Pisano, F.; Tran Anh Tuan. International Centre for Theoretical Physics, Trieste (Italy). Jul 1993. 9p. Order Number DE94611152. Source: OSTI; NTIS (US Sales Only); INIS.

We show typical features on anomaly cancellation in the 3 - n - 1 extensions of the 3 - 2 - 1 standard model, with n = 3,4 which has been proposed recently. We point out that in this class of theories a natural explanation for the fundamental question of fermion family replication arises from the theoretical requirements of renormalizability and self-consistency, which constrains the number of the QFD families to the QCD color degrees of freedom. (author). 10 refs.

7603 (IHEP-OTF–92-149) **Leptonic decay constants of heavy quarkonia in effective QCD sum rules.** Kiselev, V.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1992. 14p. Order Number DE94611160. Source: OSTI; NTIS (US Sales Only); INIS.

The QCD sum rule scheme, which allows one effectively to take into account the heavy quarkonium peculiarities such as nonrelativistic motion and large mass values of the quarks is considered. The phenomenological scaling law is derived for the leptonic constants with the use of the heavy quarkonium mass spectra. The law describes the data on the values of f_ϕ, f_ψ and f_γ rather good and predicts f_{B_c}. 12 refs.; 2 tabs.

7604 (INP-MSU–92-27-276) **QCD condensates and analytical structure of pion's form factor in sum rules methods.** Meshcheryakov, D.V. Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1992. 12p. (NIIYaF-MGU–92-27-276.). Order Number DE94611161. Source: OSTI; NTIS (US Sales Only); INIS.

A simple pion's form factor representation with physically reasonable analytical structure is applied to QCD sum rules methods. QCD condensate value are obtained through finite-energy sum rules (FESR) and Shifman-Vainstein-Zakharov sum rules (SVZ). The increase of gluon and four quark condensate values previously predicted is confirmed. 12 refs.

7605 (JINR-E–2-92-556) **The scattering of the electron on quark and the nucleon in the case of polarized particles.** Kukhto, T.V.; Panov, S.N.; Kutaev, E.A.; Sazonov, A.A. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 28p. Order Number DE94611150. Source: OSTI; NTIS (US Sales Only); INIS.

The cross section of elastic scattering of the longitudinally polarized electron on polarized quark is considered. 16 refs.; 3 figs.

7606 (KFKI–1993-11/A, pp. 107-112) **Screening of static QED electric fields in hot QCD.** Kapusta, J. (Minnesota Univ., Minneapolis, MN (United States). School of Physics and Astronomy). Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

The screening length for static QED electric fields in hot QCD is computed using hadronic degrees of freedom at low temperature and quark-gluon degrees of freedom at high temperature. The high temperature result is equivalent to computing the photon self-energy to two-loop order in QCD plus summation of the leading infrared divergent diagrams at three-loop and higher order. Comparison is made to the screening length extracted from singlet and nonsinglet susceptibilities as measured in two-flavor lattice QCD. (author) 16 refs.; 2 figs.

7607 (LA-UR–93-4147) **Back-reaction beyond the mean field approximation.** Kluger, Y. Los Alamos National Lab., NM (United States). [1993]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-930999–2: NATO Advanced Study Institute on hot and dense nuclear matter, Bodrum (Turkey), 26 Sep - 9 oct 1993). Order Number DE94003936. Source: OSTI; NTIS; INIS; GPO Dep.

A method for solving an initial value problem of a closed system consisting of an electromagnetic mean field and its quantum fluctuations coupled to fermions is presented. By tailoring the large N_f expansion method to the Schwinger-Keldysh closed time path (CTP) formulation of the quantum effective action, causality of the resulting equations of motion is ensured, and a systematic energy conserving and gauge invariant expansion about the electromagnetic mean field in powers of $1/N_f$ is developed. The resulting equations may be used to study the quantum nonequilibrium effects of pair creation in strong electric fields and the scattering and transport processes of a relativistic e^+e^- plasma. Using the Bjorken ansatz of boost invariance initial conditions in which the initial electric mean field depends on the proper time only, we show numerical results for the case in which the N_f expansion is truncated in the lowest order, and compare them with those of a phenomenological transport equation.

7608 (SLAC-PUB–6384) **Tests of the Electroweak Standard Model at high energies ($\sqrt{s}$ > 50 GeV).** Swartz, M.L. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Nov 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930823–17: 16. international symposium on lepton and photon interactions, Ithaca, NY (United States), 10-15 Aug 1993). Order Number DE94005230. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses topics on: Specification of the Minimal Electroweak Standard Model (MSM); Tree-Level Tests of the MSM; and Loop-Level Tests of the MSM.

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Refer also to citation(s) 7303, 7350, 7576, 7578, 7598, 7657, 7660, 7668, 7716, 7737

7609 (ANL-HEP-CP–93-52) **Vector leptoquark production at hadron colliders.** Hewett, J.L. (Argonne National Lab., IL (United States)); Rizzo, T.G.; Pakvasa, S.; Haber, H.E.; Pomarol,

A. Argonne National Lab., IL (United States). Sep 1993. 9p. Sponsored by USDOE, Washington, DC (United States);Texas National Research Lab. Commission, De Soto, TX (United States). DOE Contract W-31109-ENG-38. Grant RGFY93-330. (UH–511-775-93; SCIPP–93/36; CONF-9306176–18: Workshop on physics at current accelerators and the supercollider, Argonne, IL (United States), 2-5 Jun 1993). Order Number DE94003696. Source: OSTI; NTIS; INIS; GPO Dep.

We explore the production of vector leptoquarks(V) at the Tevatron, LHC, and SSC through both quark-antiquark and gluon fusion: $q\bar{q}$, $gg \rightarrow VV$. The cross sections are found to be somewhat larger than for scalar leptoquarks of the same mass implying enhanced search capabilities.

7610 (ANL-HEP-CP–93-95) **Monte Carlo event generators for hadron-hadron collisions.** Knowles, I.G. (Argonne National Lab., IL (United States). High Energy Physics Div.); Protopopescu, S.D. Argonne National Lab., IL (United States). High Energy Physics Div. Jun 1993. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9306176–14: Workshop on physics at current accelerators and the supercollider, Argonne, IL (United States), 2-5 Jun 1993). Order Number DE94003212. Source: OSTI; NTIS; INIS; GPO Dep.

A brief review of Monte Carlo event generators for simulating hadron-hadron collisions is presented. Particular emphasis is placed on comparisons of the approaches used to describe physics elements and identifying their relative merits and weaknesses. This review summarizes a more detailed report.

7611 (ANL-HEP-CP–93-99) **Deep Inelastic Scattering results from the first year of HERA operation.** Magill, S.R. Argonne National Lab., IL (United States). [1993]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9306176–19: Workshop on physics at current accelerators and the supercollider, Argonne, IL (United States), 2-5 Jun 1993). Order Number DE94004578. Source: OSTI; NTIS; INIS; GPO Dep.

The first year of operation of the HERA electron-proton collider has resulted in Deep Inelastic Scattering (DIS) Physics results from both the H1 and ZEUS experiments. Reported here are the H1 and ZEUS measurements of the proton structure function F_2 at higher Q^2 and lower x than previously reported from fixed target experiments. Also included are the results of QCD studies on hadronic final states and jets, and the observation of high Q^2 charged current events from both experiments. Finally, the observation of events with large rapidity gaps by the ZEUS collaboration is also reported.

7612 (ANL-HEP-CP–93-105) **Physics at HERA.** Derrick, M. Argonne National Lab., IL (United States). [1993]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9309297–2: 23. international symposium on multiparticle dynamics, Aspen, CO (United States), 13-17 Sep 1993). Order Number DE94005117. Source: OSTI; NTIS; INIS; GPO Dep.

HERA is the first electron-proton colliding beam facility and the big news about it is that it works, despite concerns both about the reproducibility of the magnetic field in the proton ring magnets at injection and about the e-p beam-beam interaction. It is, however, a complex accelerator facility that will take a few years to bring up to full and efficient operation. With the present center of mass energy of 296 GeV, it extends the energy range for photoproduction studies by an order of magnitude over fixed target experiments and deep-inelastic e-p scattering up to momentum transfer values approaching 10^5 GeV^2 in both neutral and charged current interactions. At reasonable Q^2, and so with the present luminosity, events with Bjorken x down to a few times 10^{-5} are being studied. Two powerful general-purpose detectors – H1 and ZEUS – have been constructed to address these physics challenges and both collaborations have made new and interesting measurements as presented at this and other recent HEP conferences. The experimental program started in July 1992 and we are on a steep learning curve both with HERA and with the detectors.

7613 (ANL/PHY/CP–80398) **Electron scattering from polarized deuterium at VEPP-3.** Jones, C.E. (and others); Coulter, K.P.; Gilman, R. Argonne National Lab., IL (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9308164–6: 14. European conference on few-body problems in physics, Amsterdam (Netherlands), 22-27 Aug 1993). Order Number DE94003204. Source: OSTI; NTIS; INIS; GPO Dep.

The experiment to measure the tensor analyzing power T_{20} of the deuteron using a tensor-polarized internal target at the VEPP-3 electron storage ring in Novosibirsk is currently in its second phase. Tensor-polarized deuterium atoms from an atomic beam source feed an active storage cell in the electron ring, serving as the target for a beam of 2 GeV unpolarized electrons. Analysis of the first Phase 2 data in the kinematic range $Q^2 = 0.36 - 0.50$ (GeV/c)^2 is reported here. Plans for the third phase of the experiment, which will use a high-density, laser-driven polarized deuterium target, are also discussed. The measurement of T_{20} from the second and third phases of the experiment will cover the kinematic region $0.36 \leq q \leq 0.90$ (GeV/c)^2 where T_{20} is particularly sensitive to isoscalar meson exchange currents.

7614 (BNL–49593) **The E2/M1 mixing ratio in the excitation of the Δ from polarized photo-reactions.** The LEGS Collaboration. Brookhaven National Lab., Upton, NY (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9308164–7: 14. European conference on few-body problems in physics, Amsterdam (Netherlands), 22-27 Aug 1993). Order Number DE94004235. Source: OSTI; NTIS; INIS; GPO Dep.

In constituent quark models, a tensor interaction, mixing quark spins with their relative motion, is introduced to reproduce the observed baryon spectrum. This has a consequence completely analogous to the nuclear tensor force between the n and p in deuterium. A D state component is mixed into what would otherwise be a purely S-wave object. The D-wave component breaks spherical symmetry, resulting in a non-vanishing matrix element for the nucleon and a static quadrupole moment and deformation for its first excited state, the Δ resonance, at ~325 MeV. The magnitude and sign of this D-state component are quite sensitive to the internal structure of the proton and have been of great interest in recent years. The intrinsic deformation of the spin 1/2 nucleon cannot be observed directly; it must be inferred from transition amplitudes such as $N \rightarrow \Delta$. In a spherical bag model, the Δ is viewed as a pure quark-spin-flip transition proceeding only through M1 excitation. If there are D-state admixtures in the ground state of the nucleon and/or Δ, quadrupole excitation, in addition to spin-flip M1, is also allowed. The problem is to evaluate the relative magnitude of this E2 excitation in the presence of the dominant M1 transition. A variety of models predict this mixing ratio to be quite small, anywhere from −0.9% to −6%, so that a high degree of precision is demanded of experiment.

7615 (BNL–49665) **Production of φ mesons in central Si + Au collisions at 14.6 A·GeV/c.** Wang, Yufeng (Columbia Univ., New York, NY (United States). Nevis Labs.). E-802 Collaboration. Brookhaven National Lab., Upton, NY (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-930636–10: 10. international conference on ultra-relativistic nucleus-nucleus collisions, Borlaenge (Sweden), 20-24 Jun 1993). Order Number DE94003196. Source: OSTI; NTIS; INIS; GPO Dep.

The production of φ mesons from, central Si + Au collisions has been measured by E859 at the BNL-AGS by selecting events with identified K^+K^- pairs. The values for the mass and width of the φ obtained from the invariant mass of the kaon pairs are consistent with those of the Particle Data Book. Preliminary results for the invariant $1/2\pi m_T \, d^2n/dm_T dy$ distribution and dN/dy are presented.

7616 (BUDKERINP–91-110) **Measurement of the branching ratio for Υ(1s) state into $\mu^+\mu^-$ and search for decays $\upsilon(1s) \rightarrow \pi^+\pi^-$, K^+K^-, pp-bar.** Baru, S.E. (and others); Bejlin, M.V.; Blinov, A.E. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1991. 18p. (IYaF–91-110.). Order Number DE94611207. Source: OSTI; NTIS (US Sales Only); INIS.

In the experiment with e^+e^--beams performed at the VEPP-4 storage ring with the MD-1 detector have been measured $B_{\mu\mu}$,

the branching ratio for the decay of $\upsilon(1S)$ state into $\mu^+\mu^-B_{\mu\mu}$=(2.12+0.20+0.10)% is obtained. It is shown that the continuum and resonance interference should be taken into account. For the first time the upper limits on the branching ratio for the decays $\upsilon\rightarrow\pi^+\pi^-$, K^+K^-, pp-bar have been obtained: $Br(\upsilon\rightarrow\pi^+\pi^-)<5x10^{-4}$, $Br(\upsilon\rightarrow K^+K^-)<5x10^{-4}$, $Br(\upsilon\rightarrow$pp-bar$)<5x10^{-4}$. 26 refs.; 6 figs.; 7 tabs.

7617 (BUDKERINP–92-61) **Low energy theorems from the effective Lagrangian with vector mesons.** Silagadze, Z.K. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1992. 15p. (IYaF–92-61.). Order Number DE94611173. Source: OSTI; NTIS (US Sales Only); INIS.

It is shown that the previously proposed effective Lagrangian with vector mesons correctly reproduces all current algebra low-energy theorems in the domain of its validity. 12 refs.

7618 (DOE/ER/00881–T3) **An analysis of monojet data in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TEV.** Markeloff, R. Wisconsin Univ., Madison, WI (United States). 1992. 179p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76ER00881. Order Number DE94001822. Source: OSTI; NTIS; INIS; GPO Dep.

An analysis is presented of events with a single jet and significant missing transverse energy selected from 4.7 pb^{-1} of data collected at the Fermilab Tevatron with the CDF detector. The goal is to identify events of the type $p\bar{p} \rightarrow Z^0$ + jet; $Z^0 \rightarrow \nu\bar{\nu}$. Event selection and backgrounds are discussed. The number of observed monojet events is compared to the number of observed $Z^0 \rightarrow e^{+-}$ events in which the Z^0 is accompanied by a jet. We measure the number of light neutrino species to be $N_\nu = 2.2\pm1.5$ and we place an upper limit on the number of neutrino species at $N_\nu < 5$ (90% C.L.).

7619 (DOE/ER/00881–T5) **Properties of events containing a photon and several jets seen in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV.** Maas, P.A. Wisconsin Univ., Madison, WI (United States). 1993. 172p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76ER00881. Order Number DE94005596. Source: OSTI; NTIS; INIS; GPO Dep.

The CDF detector is used to investigate the properties of events containing a photon and two jets. The rate of photon +2 jet production is higher than the theoretical calculation, but the shape of the events agrees with QCD predictions.

7620 (DOE/ER/10629–T4) **A study of the decay $D^\circ \rightarrow K^-\pi^+\pi^\circ$ in high energy photoproduction.** Summers, D.J. (Univ. of California, Santa Barbara, CA (United States)); Bharadwaj, V.K.; Denby, B.H.; Eisner, A.M.; Lu, A.; Morrison, R.J.; Witherell, M.S.; Yellin, S.J.; Kennett, R.G.; Estabrooks, P.; Pinfold, J.; Bartlett, D.F.; Bhadra, S.; Duncan, A.L.;Oklahoma Univ., Norman, OK (United States). [1983]. 133p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AS05-80ER10629. Order Number DE94004874. Source: OSTI; NTIS; GPO Dep.

Results are presented from an experiment observing photoproduction of the D^* at an average energy of 103 GeV. Clean signals are seen for the decay $D^{*\pm} \rightarrow \pi^\pm D^0$ with the D^0 decaying into both $K^\mp\pi^\pm$ and $K^\mp\pi^\pm\pi^0$. Analysis of the Dalitz plot for the $K\pi\pi$ mode gives branching fractions for $K^-\rho^+$, $K^{*-}\pi^+$, and $\bar{K}^{*0}\pi^0$ final states. The observed branching fraction for $D^0 \rightarrow K^-\rho^+$, which is much lower than a previous result, is in approximate agreement with the value expected for an I = 1/2 final state.

7621 (DOE/ER/40445–43) **A search for the production of Direct Leptons in nucleon-nucleus and nucleus-nucleus collisions: Progress report, April 1, 1991–December 1, 1993.** Kirk, P.N. Louisiana State Univ., Baton Rouge, LA (United States). 15 Dec 1993. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-88ER40445. Order Number DE94004640. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this report is to describe activities performed by the Intermediate Energy Nuclear Physics Group (IENPG) at the Louisiana State University (LSU) under the terms of grant FG05-88ER40445. The report will cover, for the most part, the period of time between April 1, 1991, and the present. The principal focus of our activities is currently the muon subgroup of the PHENIX Collaboration. We are, however, in the process of concluding other activities, specifically our memberships in the Di-Lepton Spectrometer (DLS) Collaboration at LBL and the AMY Collaboration at KEK. These activities have been thoroughly discussed in previous progress reports and renewal proposals, and further discussion of these activities is possibly repetitious. However, this report has been prepared under the assumption that none of the referees with the exception of the grant monitor is familiar with the group or its previous work. Consequently we shall cite a few examples of our contributions to these collaborations when there seem to be valid reasons for so doing.

7622 (DOE/ER/40654–3) **Harvard University High Energy Physics: [Annual report, 1992–1993].** Harvard Univ., Cambridge, MA (United States). [1993]. 44p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER40654. Order Number DE94002406. Source: OSTI; NTIS; INIS; GPO Dep.

The mainly experimental research program in high energy physics at Harvard is summarized in a descriptive fashion according to the following outline: Proton–antiproton colliding beam program at Fermilab – CDF (forward/backward electromagnetic calorimeters – FEM, central muon extension – CMX, gas calorimetry and electronics development, front-end electronics upgrades, software development, physics analysis, timetable), electron – positron collisions in the upsilon region – CLEO (the hardware projects including CLEO II barrel TOF system and silicon drift detector R&D, physics analysis), search for ν_μ to ν_τ oscillations with the NOMAD experiment at CERN, the solenoidal detector collaboration at the SSC, muon scattering at FNAL – E665, the L3 experiment, and phenomenological analysis of high-energy $\bar{p}p$ cross sections. 149 refs.

7623 (DOE/ER/40685–759) **Theoretical and experimental studies of elementary physics: Annual technical progress report, November 1, 1992–October 31, 1993.** Bodek, A.; Ferbel, T.; Melissinos, A.C.; Slattery, P.; Tipton, P.; Das, A.; Hagen, C.R.; Rajeev, S.G.; Okubo, S.; Orr, L. Rochester Univ., NY (United States). Dept. of Physics and Astronomy. 1 May 1993. 166p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER40685. Order Number DE94002310. Source: OSTI; NTIS; INIS; GPO Dep.

The various components of the high-energy physics research program at the University of Rochester are presented. (I)Fixed-target experimentation at FNAL includes studies of direct photon production by p and π on H, Be, and Cu, and hybrid mesons and other physics issues in Coulomb excitation at high energies. (II)The status of the GEM (Gammas, Electrons, and Muons) Experiment at the SSC is given. (III)The D-Zero experiment at FNAL is reviewed. (IV)Deep inelastic lepton–nucleon scattering experiments are summarized: electron scattering experiments at SLAC, FNAL neutrino quad triplet runs, FNAL neutrino sign selected experiments, and SDC cosmic ray test and test beam calibration. (V)Studies of nonlinear QED at SLAC concentrated on a study of QED at critical field strength in intense laser–high-energy electron collisions. (VI)Development work on the Collider Detector at Fermilab (CDF) emphasized the CDF silicon vertex detector, the end plug calorimeter, and the SDC tile/fiber calorimetry. (VII)The theoretical physics effort is sketched.

7624 (FNAL/C–93/305) **A dependence of exclusive vector meson production in muon-nucleus scattering.** Fang, Guang Yin (Harvard Univ., Cambridge, MA (United States). Dept. of Physics). E665 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-930637–11: 13. international conference on particles and nuclei, Perugia (Italy), 27 Jun - 3 jul 1993). Order Number DE94003363. Source: OSTI; NTIS; INIS; GPO Dep.

Preliminary results on the cross section ratios of exclusive ρ^0 and ϕ meson production off carbon, calcium, and lead to that off deuterium in deep-inelastic muon-nucleon scattering are reported. The data were taken with the E665 spectrometer using the Fermilab Tevatron muon beam. The mean beam energy was 470 GeV. Significant increase in the cross section ratios is seen as the four-momentum squared of the virtual photon increases. The results support the idea of color transparency.

7625 (FNAL/C–93/313-E) **Measurement of the elastic, total and single diffraction cross sections at Tevatron energies.** Belforte, S. (Istituto Nazionale di Fisica Nucleare, Pisa (Italy)). CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9306134–4: Conference on hadron, Como (Italy), 21-25 Jun 1993). Order Number DE94003618. Source: OSTI; NTIS; INIS; GPO Dep.

CDF collaboration has measured the differential elastic cross section $d\sigma_{el}/dt$, the single diffraction dissociation double differential cross section $d^2\sigma_{sd}/dM^2dt$ and the total inelastic cross section in antiproton-proton collisions at center of mass energies $\sqrt{s}$=546 and 1800 GeV. The elastic scattering slope is 15.28±0.58 (16.98±0.25) GeV^{-2} at $\sqrt{s}$ = 546 (1800) GeV. Using the luminosity independent method, $(1 + \rho^2)\sigma_T$ is measured to be 62.64±0.95 (81.83±2.29) mb at $\sqrt{s}$ = 546 (1800) GeV. Assuming ρ = 0.15, the elastic, total and signal diffraction cross sections are σ_{el} = 12.87±0.30, σ_T = 61.26±0.93 and σ_{sd} = 7.89±0.33 mb (σ_{el} = 19.70±0.85, σ_T = 80.03±2.24 and σ_{sd} = 9.46±0.44 mb) at 546 (1800) GeV.

7626 (FNAL/C–93/320-E) **New particle searches at CDF.** Cobal, M. (Istituto Nazionale di Fisica Nucleare, Pisa (Italy)). CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 6p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Istituto Nazionale di Fisica Nucleare, Rome (Italy);Ministry of Education, Science and Culture (Japan);Natural Sciences and Engineering Research DOE Contract AC02-76CH03000. (CONF-930761–3: International Europhysics conference on high-energy physics, Marseille (France), 22-28 Jul 1993). Order Number DE94003641. Source: OSTI; NTIS; INIS; GPO Dep.

We present a review of the search for new particles, such as leptoquarks, excited quarks, SUSY and top at CDF.

7627 (FNAL/C–93/328) **Heavy quark production and spectroscopy.** Appel, J.A. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-930823–16: 16. international symposium on lepton and photon interactions, Ithaca, NY (United States), 10-15 Aug 1993). Order Number DE94003619. Source: OSTI; NTIS; INIS; GPO Dep.

This review covers many new experimental results on heavy flavor production and spectroscopy. It also shows some of the increasingly improved theoretical understanding of results in light of basic perturbative QCD and heavy quark symmetry. At the same time, there are some remaining discrepancies among experiments as well as significant missing information on some of the anticipated lowest lying heavy quark states. Most interesting, perhaps, are some clearly measured production effects awaiting full explanation.

7628 (FNAL/C–93-329-E) **Top quark search at CDF.** Benlloch, J.M. (Massachusetts Inst. of Technology, Cambridge, MA (United States)). CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9305311–1: New physics in new experiments meeting, Kazimierz (Poland), May 1993). Order Number DE94003643. Source: OSTI; NTIS; INIS; GPO Dep.

The current status of the Top quark search at CDF is presented. A lower limit on the Top mass of 113 GeV has been established using the dilepton channel with the data collected during the 1988–1989 and 1992–1993 runs at $\sqrt{s}$= 1.8 TeV. Prospects for Top quark discovery during the 1993–1994 run are also outlined.

7629 (FNAL/C–93/330-E) **Photon and hadron production of heavy flavors.** DeJongh, F. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9307143–6: 5. international symposium on heavy flavor physics, Montreal (Canada), 6-10 Jul 1993). Order Number DE94004655. Source: OSTI; NTIS; INIS; GPO Dep.

Recent experiments have obtained large clean samples of charmed and bottom hadrons, and have measured both single-quark inclusive cross-sections and quark-antiquark correlations. Predictions for these production properties are available from next-to-leading order QCD. We review recent results from fixed target hadroproduction of charm and bottom, fixed target photoproduction of charm, and production of bottom at proton-antiproton colliders.

7630 (FNAL/C–93/333) **Heavy flavor production at fixed target photo- and hadroproduction.** Kwan, S. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9309292–3: Advanced study conference on heavy flavours, Pavia (Italy), 3-7 Sep 1993). Order Number DE94004651. Source: OSTI; NTIS; INIS; GPO Dep.

Recent results on photo- and hadroproduction of heavy flavor particles from fixed target experiments at CERN and Fermilab are presented. These include results on production characteristics, cross-section and pair correlation for both charm and beauty mesons.

7631 (FNAL/C–93.345-E) **Jet production in muon scattering at Fermilab E665.** Salgado, C.W. E665 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9309297–1: 23. international symposium on multiparticle dynamics, Aspen, CO (United States), 13-17 Sep 1993). Order Number DE94004663. Source: OSTI; NTIS; INIS; GPO Dep.

Measurements of multi-jet production rates from Muon-Nucleon and Muon-Nuclei scattering at Fermilab-E665 are presented. Jet rates are defined by the JADE clustering algorithm. Rates in Muon-Nucleon deep-inelastic scattering are compared to Monte Carlo model predictions. Preliminary results from jet production on heavy targets, in the shadowing region, show a higher suppression of two-forward jets as compared to one-forward jet production.

7632 (FNAL/C–93/347-E) **Search for excited quarks in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV.** Kephart, R.D. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9310247–1: 9. workshop on proton-antiproton collider physics, Tsukuba (Japan), 18-22 Oct 1993). Order Number DE94004658. Source: OSTI; NTIS; INIS; GPO Dep.

If quarks are composite particles then excited states are expected. We have searched in $p\bar{p}$ collisions for excited quarks (q^*) which decay to common quarks by emitting a W boson ($q^* \rightarrow qW$) or a photon ($q^* \rightarrow q\gamma$). The simplest model of excited quarks has been excluded for mass $M^* < 540$ GeV/c^2 at 95% confidence level.

7633 (FNAL/C–93/349-E) **A search for rapidity gap events in $p\bar{p}$ collisions at D0.** Streets, K.T. (Maryland Univ., College Park, MD (United States)). D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 4p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-930761–6: International Europhysics conference on high-energy physics, Marseille (France), 22-28 Jul 1993). Order Number DE94004654. Source: OSTI; NTIS; INIS; GPO Dep.

Preliminary results from a search for jet events with rapidity gaps are presented. These events were produced in $p\bar{p}$ interactions at $\sqrt{s}$ = 1.8 TeV and measured with the Dv detector at Fermilab. The fraction of events with a rapidity gap is measured as a function of the pseudo-rapidity difference between the cone edges of the two leading jets ($\Delta\eta_c$). An upper limit on the fraction of events with no particles between jets is measured at 0.0093 at a 90% confidence level for events with $\Delta\eta_c > 3$ and jet transverse energies greater than 30 GeV.

7634 (FNAL/C–93/352-E) **B production and $B^0\bar{B}^0$ mixing at D0.** Denisov, D. (Superconducting Super Collider Lab., Dallas, TX (United States)). D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9309292–2: Advanced study conference on

heavy flavours, Pavia (Italy), 3-7 Sep 1993). Order Number DE94004664. Source: OSTI; NTIS; INIS; GPO Dep.

Preliminary results on B physics studies from the D0 experiment at the Fermilab collider are presented. Single and dimuon events produced in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV were used in the analysis. Inclusive single muon and J/Ψ differential cross sections are shown. The results of a measurement of the time averaged $B^0\bar{B}^0$ to mixing parameter are presented.

7635 (FNAL/C–93/358-E) **Measurement of the elastic, total and diffraction cross sections at tevatron energies.** Belforte, S. (Istituto Nazionale di Fisica Nucleare, Pisa (Italy)). CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-930761–5: International Europhysics conference on high-energy physics, Marseille (France), 22-28 Jul 1993). Order Number DE94004659. Source: OSTI; NTIS; INIS; GPO Dep.

The CDF collaboration has measured the differential elastic cross section $d\sigma_{el}/dt$, the single diffraction dissociation double differential cross section $d^2\sigma_{sd}/dM^2dt$ and the total inelastic cross section for antiproton-proton collisions at center of mass energies $\sqrt{s}$ = 546 and 1,800 GeV. Data for this measurement have been collected in short dedicated runs during the 1988–1989 data taking period of CDF. The elastic scattering slope is 15.28 ± 0.58 (16.98 ± 0.25) GeV^{-2} at $\sqrt{s}$ = 546 (1,800) GeV. Using the luminosity independent method $(1 + \rho^2)\sigma_T$ is measured to be 62.64 ± 0.95 (81.83 ± 2.29) mb at $\sqrt{s}$ = 546 (1,800) GeV. Assuming ρ = 0.15 the elastic, total and single diffraction cross sections are σ_{el} = 12.87 ± 0.30, σ_T = 61.26 ± 0.93 and σ_{sd} = 7.89 ± 0.33 mb (σ_{el} = 19.70 ± 0.85, σ_T = 80.03 ± 2.24 and σ_{sd} = 9.46 ± 0.44 mb) at $\sqrt{s}$ = 546 (1,800) GeV.

7636 (FNAL/C–93/363-E) **Search for the top quark in the single lepton + jets channel at D0.** Greenlee, H.B. D0 collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9310247–3: 9. workshop on proton-antiproton collider physics, Tsukuba (Japan), 18-22 Oct 1993). Order Number DE94004660. Source: OSTI; NTIS; INIS; GPO Dep.

We have searched for standard model top quark pair production at $\sqrt{s}$ = 1.8 TeV. We present preliminary results of searches in the single lepton decay modes (i.e. where one top quark decays semileptonically to an electron or a muon and the other top quark decayed hadronically). We do not find evidence for top quark production in these decay channels. By combining this negative result with our negative result from the dilepton decay channels, we obtain a 95% confidence level upper limit on the top quark production cross section for top masses between 80 and 140 GeV/c^2. By comparing this cross section upper limit curve with a theoretical production cross section we obtain a lower limit on the top quark mass of 124 GeV/c^2.

7637 (IC–93/221) **On the corrections to pole dominance in B → πlν.** Paver, N. (Trieste Univ. (Italy). Ist. di Fisica Teorica); Riazzudin. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 8p. (UTS-DFT–93-20.). Order Number DE94611208. Source: OSTI; NTIS (US Sales Only); INIS.

In the framework combining the heavy quark expansion and chiral symmetry for light quarks, we identify a class of corrections to the dominant vector meson pole diagram for B → πlν, in the vicinity of the zero pion recoil point. We also give a qualitative estimate of these effects, using higher states exchanges with couplings constrained by current algebra and PCAC. (author). 12 refs, 1 fig.

7638 (IC–93/231) **Decay of the D_s-meson.** Duong Van Phi (International Centre for Theoretical Physics, Trieste (Italy)); Duong Anh Duc. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 9p. Order Number DE94611209. Source: OSTI; NTIS (US Sales Only); INIS.

The decay channels of the D_s-meson are deduced from a Selection Rule and a Lagrangian, formed on L*O(4) group invariance and on principle of minimal structure. A comparison of the results with experimental data is made. (author). 4 refs.

7639 (IHEP-OMMS–92-52) **Angular dependence of parton-parton scattering extracted from hadron pair production in pp collisions at $\sqrt{s}$=11.5 GeV.** Volkov, A.A. (and others); Kostritskij, A.V.; Abramov, V.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1992. 6p. Order Number DE94611174. Source: OSTI; NTIS (US Sales Only); INIS.

The angular dependence of symmetrical hadron pair production cross section with effective mass in the range of 2.95-4.7 GeV/c^2 is measured with a GCD-based calculations double arm spectrometer. The results are compared to calculations based on QCD. 12 refs.; 1 fig.

7640 (IS-T–1654) **A measurement of the (τ) polarization at the Z resonance with the DELPHI detector at LEP.** Wong Chan, A. Ames Lab., IA (United States). Jul 1993. 148p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005557. Source: OSTI; NTIS; INIS; GPO Dep.

The polarization of τ leptons produced in the reaction $e^+e^- \rightarrow \tau^+\tau^-$ near the peak of the Z^o resonance has been measured using a sample of 24904 $\tau^+\tau^-$ events, with an estimated background of 1.5%. We have selected 4562 $\tau \rightarrow e\nu\bar{\nu}$ 2218 $\tau \rightarrow \pi\nu$ and 5133 $\tau \rightarrow \rho\nu$ candidates. The mean value obtained is $P_\tau = -0.176 \pm 0.029$. This corresponds to a ratio of the neutral current vector to the axial-vector coupling constants of the τ lepton of $g_V^\tau/g_A^\tau = 0.088 \pm 0.014$. This leads to a value of the electroweak mixing angle of $\sin^2\theta_W = 0.2280 \pm 0.0036$. This result is in good agreement with previous measurements of the weak mixing angle from the study of the Z^o lineshape and the forward-backward asymmetries in the processes $Z^o \rightarrow l^+l^-$ and $Z^o \rightarrow q\bar{q}$.

7641 (JINR-E–2-92-115) **Form factors of the decay D+->antiK*0e+νe.** Volkov, M.K. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 10p. Order Number DE94611210. Source: OSTI; NTIS (US Sales Only); INIS.

Simple phenomenological estimates of the vector V(0) and axial $A_1(0)$ and $A_2(0)$ form factors of the D+->anti*0e+νe decay are made in the model of the Nambu-Jona-Lasinio type. The obtained form factors agree with the experimental data. 21 refs.; 2 figs.; 1 tab.

7642 (JINR-R–2-92-217) **Proton elecromagnetic form factor near PantiP threshold.** Meshcheryakov, V.A.; Meshcheryakov, G.V. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 7p. (In Russian). Order Number DE94611221. Source: OSTI; NTIS (US Sales Only); INIS.

The influence of the PantiP-state in the unitarity condition on the behaviour of the proton form factor in the time-like region is considered. 16 refs.; 2 figs.; 1 tab.

7643 (Juel–2733) **The elastic pion-nucleon interaction in the meson exchange picture.** Schuetz, C. Forschungszentrum Juelich GmbH (Germany). Inst. fuer Kernphysik. Feb 1993. 98p. (In German). Order Number DE94734009. Source: OSTI; NTIS (US Sales Only); INIS.

We report a meson exchange model of pion-nucleon interaction, which has recently been developed by our group. Apart from direct and exchange nucleon and delta pole diagrams the Born term of this model includes potentials for the correlated exchange of two pions in the 0^+ ('σ') and 1^- (ρ) channels. These 2π-exchange potentials are calculated from partial wave amplitudes for the reaction N anti N → ππ using the technique of dispersion integrals. Our 2π-exchange potentials are compared with potentials derived from the exchange of 'σ'- and ρ-mesons in conventional meson exchange models, in which the mass distribution of the exchanged 2π-system is neglected. By an investigation of the characteristic differences of these potentials we show that the realistic treatment of correlated 2π-exchange is of crucial importance for the quantitative description of πN scattering data obtained in our model. The rise of the P_{11} phase shift is reproduced without an explicit pole term involving the N*. The description of this partial wave is based on the cancellation between the strong attraction from correlated 2π-exchange and a repulsive contribution from the nucleon pole term. (orig.)

7644 (LA–12635-T) **A photon detector system for the search for the rare muon decay $\mu \rightarrow e\gamma$.** Van Ausdeln, L.A. Los Alamos National Lab., NM (United States). Nov 1993. 162p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003537. Source: OSTI; NTIS; INIS; GPO Dep.

Thesis submitted to Texas A&M University, College Station, TX.

An innovative and state of the art pair spectrometer system to measure the photon component of μ^+ decay to obtain an improved branching ratio limit for the decay $\mu \rightarrow e\gamma$ is investigated. Analysis algorithms are developed and an experimental inner bremsstrahlung spectrum is obtained and agrees well with Monte Carlo simulations. Background sources are investigated and found to be highly suppressed at various stages of acquisition and analysis.

7645 (LA–12663-T) **Reaction $\pi N \rightarrow \pi\pi N$ near threshold.** Friez, E. Los Alamos National Lab., NM (United States). Nov 1993. 278p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003895. Source: OSTI; NTIS; INIS; GPO Dep.

Thesis submitted to University of Virginia, Dept. of Physics, Charlottesville, VA.

The LAMPF E1179 experiment used the π^0 spectrometer and an array of charged particle range counters to detect and record $\pi^+\pi^0$, $\pi^0 p$, and $\pi^+\pi^0 p$ coincidences following the reaction $\pi^+ p \rightarrow \pi^0\pi^+ p$ near threshold. The total cross sections for single pion production were measured at the incident pion kinetic energies 190, 200, 220, 240, and 260 MeV. Absolute normalizations were fixed by measuring $\pi^+ p$ elastic scattering at 260 MeV. A detailed analysis of the π^0 detection efficiency was performed using cosmic ray calibrations and pion single charge exchange measurements with a 30 MeV π^- beam. All published data on $\pi N \rightarrow \pi\pi N$, including our results, are simultaneously fitted to yield a common chiral symmetry breaking parameter $\xi = -0.25 \pm 0.10$. The threshold matrix element $|\alpha_0(\pi^0\pi^+ p)|$ determined by linear extrapolation yields the value of the s-wave isospin-2 $\pi\pi$ scattering length $\alpha_0{}^2(\pi\pi) = -0.041 \pm 0.003\ m_\pi{}^{-1}$, within the framework of soft-pion theory.

7646 (LBL–34726) **The STAR experiment at the Relativistic Heavy Ion Collider.** Harris, J.W. STAR Collaboration. Lawrence Berkeley Lab., CA (United States). Sep 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-930636–9: 10. international conference on ultra-relativistic nucleus-nucleus collisions, Borlaenge (Sweden), 20-24 Jun 1993). Order Number DE94003409. Source: OSTI; NTIS; INIS; GPO Dep.

The STAR experiments will concentrate on measurements of hadron production over a large solid angle to be able to study observables on an event-by-event basis. STAR will search for signatures of QGP formation and investigate the behavior of strongly interacting matter at high energy density. Since there is no single definitive signature for the QGP, it is essential to use a flexible detection system at RHIC. STAR will simultaneously measure many experimental observables to study signatures of the phase transition and the space-time evolution of the collision process. This requires an understanding of the microscopic structure of hadronic interactions, at the level of quarks and gluons, at high energy densities. The experiment will utilize two aspects of hadron production that are fundamentally new at RHIC: correlations between global observables on an event-by-event basis and the use of hard scattering of partons as a probe of the properties of high density nuclear matter.

7647 (LBL–34738) **Properties of W + jet events in proton-antiproton collisions at 1.8 TeV.** Drucker, R.B. (Lawrence Berkeley Lab., CA (United States)). CDF Collaboration. Lawrence Berkeley Lab., CA (United States). 22 Nov 1993. 189p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94004002. Source: OSTI; NTIS; INIS; GPO Dep.

W boson + QCD Jet events, produced in 1.8 TeV proton-antiproton collisions and measured by the Collider Detector at Fermilab (CDF), were used to measure the center-of-mass production angle of the W + jet system, and were also used to place limits on the production of excited quark states. The center-of-mass production angular distribution agrees well with leading order and next-to-leading order QCD predictions. Excited quark states were searched for in the reaction $q + g \rightarrow q^* \rightarrow q + W$. Upper limits on the q^* cross section, as a function of the q^* mass, are shown. Comparison with a theoretical prediction for q^* production excludes excited quark states with a mass in the range 150–530 GeV/c^2, at 95% confidence.

7648 (LIYaF–1765) **Limitation on the magnetic dipole moment of the reactor neutrino.** Derbin, A.V. AN SSSR, Leningrad (Russian Federation). Inst. Yadernoj Fiziki. Jan 1992. 16p. (In Russian). Order Number DE94611171. Source: OSTI; NTIS (US Sales Only); INIS.

Results of experiments on elastic scattering of reactor neutrino on electron are presented. Limitation on the magnetic moment of neutrino $\mu_\nu < 1.8 \times 10^{-10}\ \mu_B$ was obtained. The existing uncertainty in the neutrino spectrum confines the possible limit on magnetic moment of $\approx 3 \times 10^{-11}\ \mu_B$ value for detectors with $\approx$0.1 MeV threshold. 26 refs.; 5 figs.; 1 tab.

7649 (SLAC-PUB–6096) **A study of LPM suppression of bremsstrahlung at 25 GeV.** Anthony, P. (Lawrence Livermore National Lab., CA (United States)); Becker-Szendy, R.; Bosted, P. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Mar 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930779–18: International cosmic-ray conference, Calgary (Canada), 19-20 Jul 1993). Order Number DE94003457. Source: OSTI; NTIS; INIS; GPO Dep.

We are making an accurate measurement of the LPM suppression of bremsstrahlung with 25 GeV electrons. By using a 120 pulses per second beam, a precise BGO calorimeter, and spectrometer to tag the outgoing electrons, we are able to make an accurate measurement of the bremsstrahlung photons in the 0-400 MeV region, where the Bethe Heitler and LPM predictions differ. We are taking data with targets made of carbon, uranium, tungsten and iron, with thicknesses in the 2% to 6% X_0 range. In addition, we are taking data with two very thin gold targets. The latter have thicknesses that are comparable to or less than the LPM formation zone length, and so should not exhibit LPM suppression. We are also studying photons of a few MeV in energy, to test the closely related longitudinal density effect predicted by Ter-Mikaelian in which very low energy photon emission is suppressed due to dielectric effects of the medium.

7650 (SLAC-PUB–6292) **A measurement of $R_b = \Gamma(Z^0 \rightarrow b\bar{b})/\Gamma(Z^0 \rightarrow$ hadrons) at SLD.** SLD Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Sep 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930823–15: 16. international symposium on lepton and photon interactions, Ithaca, NY (United States), 10-15 Aug 1993). Order Number DE94003446. Source: OSTI; NTIS; INIS; GPO Dep.

A measurement of the ratio $R_b = \Gamma(Z^0 \rightarrow b\bar{b})/\Gamma(Z^0 \rightarrow$ hadrons) is reported. This measurement is made using the CCD-based vertex detector of the SLD detector at the SLAC Linear Collider. Efficient tagging of $b\bar{b}$ events is performed with an impact parameter technique that takes advantage of the small and stable interaction point of the SLC and all charged tracks in Z^0 decays. In a sample of 27K Z^0 events, a value $R_b = 0.235 \pm 0.006 \pm 0.018$ is obtained.

7651 (SLAC-PUB–6362) **A study of jet handedness at the Z^0 resonance.** Masuda, H. SLD Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Oct 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930761–2: International Europhysics conference on high-energy physics, Marseille (France), 22-28 Jul 1993). Order Number DE94003450. Source: OSTI; NTIS; INIS; GPO Dep.

We present a preliminary study of jet handedness is hadronic decays of Z^0 bosons measured in the SLD experiment at the SLAC Linear Collider (SLC). Following the proposal of Nachtman and Efremov et al., we defined a scalar quantity for each hadronic jet

and measured the sign asymmetry (jet handedness) of this quantity for samples of quark jets and antiquark jets, which are expected to be oppositely polarized in Z^0 decays. From our preliminary study, no evidence for a significantly non-zero handedness was observed. Assuming standard model values of quark polarizations, we set an upper limit on the analyzing power of our handedness method.

7652 (SLAC-PUB–6378) **A measurement of the LMP effect.** Klein, S.R. (California Univ., Santa Cruz, CA (United States). Inst. for Particle Physics); Anthony, P.; Becker-Szendy, R. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Nov 1993. 16p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00515 ; W-7405-ENG-48. NSF-PHY-9113428; NSF-PHY-9114958. (CONF-930823–18: 16. international symposium on lepton and photon interactions, Ithaca, NY (United States), 10-15 Aug 1993). Order Number DE94005225. Source: OSTI; NTIS; INIS; GPO Dep.

We have performed an experiment to measure accurately the Landau-Pomeranchuk-Migdal (LPM) effect in the production of 5 to 500 MeV photons due to bremsstrahlung of 8 and 25 GeV electron beams traversing thin (2 to 6% X_0) targets of varying densities. Our measurements confirm that the LPM effect exists and that the Migdal calculations are accurate. We see that, for thin targets, LPM suppression disappears leaving a Bethe-Heitler spectrum, as predicted by theory. For intermediate target thicknesses, we lack an acceptable theory, but have measured energy spectra for targets of differing thickness. We have also measured the production rate of 500 keV to 5 MeV photons at the same electron energies, to study dielectric suppression. We see qualitative agreement with the theory of Ter-Mikaelian; more work is needed before we can make quantitative comparisons.

6624 Properties of Specific Particles and Resonances

Refer also to citation(s) 7311, 7317, 7350, 7594, 7596, 7597, 7601, 7609, 7611, 7614, 7615, 7620, 7621, 7622, 7624, 7626, 7627, 7628, 7629, 7632, 7636, 7647, 7706

7653 (ANL-HEP-CP–93-86) **Rescattering and energy loss of fast partons in nuclear matter.** Fields, T. (Argonne National Lab., IL (United States)); Corcoran, M. Argonne National Lab., IL (United States). [1993]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-930761–4: International Europhysics conference on high-energy physics, Marseille (France), 22-28 Jul 1993). Order Number DE94002918. Source: OSTI; NTIS; INIS; GPO Dep.

We compare nuclear rescattering and energy loss effects as seen in dijet production in Fermilab fixed target experiment E609 with theoretical estimates and with data from Drell-Yan dilepton production. Possible explanations for these effects being unusually large in dijet production are briefly discussed.

7654 (ANL-HEP-CP–93-94) **Report of the subgroup on the top quark.** Yuan, C.P. (Michigan State Univ., East Lansing, MI (United States)); Nodulman, L.; Baer, H. Argonne National Lab., IL (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9306176–20: Workshop on physics at current accelerators and the supercollider, Argonne, IL (United States), 2-5 Jun 1993). Order Number DE94004624. Source: OSTI; NTIS; INIS; GPO Dep.

The top group studied discovery issues as well as measurements to be made at the Tevatron, the LHC and the SSC.

7655 (ANL-HEP-CP–93-102) **Matrix elements for the decays of S- and P-wave quarkonium: An exploratory study.** Bodwin, G.T.; Kim, S.; Sinclair, D.K. Argonne National Lab., IL (United States). Nov 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310250–3: LATTICE 93: international symposium on lattice field theory, Dallas, TX (United States), 12-17 Oct 1993). Order Number DE94005127. Source: OSTI; NTIS; INIS; GPO Dep.

Bodwin, Braaten and Lepage have shown that, in a non-relativistic expansion in powers of the heavy-quark velocity, the decay rates of S- and P-wave quarkonia can be written as sums of products of a hard parton matrix element, which can be calculated perturbatively, times a low-momentum expectation value of a parton operator in the quarkonium state. We report on attempts to calculate these low momentum matrix elements on the lattice in the non-relativistic formulation of the quark dynamics. The quenched approximation is used throughout.

7656 (CONF-9306260–5) **Signatures for hybrids.** Barnes, T. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). [1993]. 13p. Sponsored by US-DOE, Washington, DC (United States);Science and Engineering Research Council, Swindon (United Kingdom). DOE Contract AC05-84OR21400. From Conference on exclusive reactions at high momentum transfer; Elba (Italy); 24-26 Jun 1993. Order Number DE94004244. Source: OSTI; NTIS; INIS; GPO Dep.

In this review talk I summarize theoretical expectations for properties of hybrid mesons and baryons, and discuss the prospects for identifying these states experimentally.

7657 (FNAL/C–93/319-E) **B-lifetime measurements at the tevatron.** Wenzel, H. (Fermi National Accelerator Lab., Batavia, IL (United States)). CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9309292–1: Advanced study conference on heavy flavours, Pavia (Italy), 3-7 Sep 1993). Order Number DE94003617. Source: OSTI; NTIS; INIS; GPO Dep.

During the run period from May 1992 to begin of June 1993 the Collider Detector at Fermilab (CDF) has recorded $\approx$ 21.4 pb^{-1} of $p\bar{p}$ collider data at $\sqrt{s}$ = 1.8 TeV. For this run the detector had been upgraded which significantly enhanced its b-physics capabilities. The upgrades include a high precision Silicon VerteX detector (SVX) which enables CDF to reconstruct the decay vertex and decay length of b-hadrons. In this article the author reports on several measurements of the lifetime of b-flavored hadrons. The determination of the average b-lifetime using inclusive J/ψ's, the measurement of the $B^{\pm}$ and B^0 lifetimes by reconstructing exclusive final states including a J/ψ or $\psi(2S)$ and a measurement of the $B_s{}^0$ meson lifetime exploiting the decay: $B_s \rightarrow l\nu D_s{}^+ \rightarrow l\nu\phi\pi^+ \rightarrow l\nu K^+K^-\pi^+$.

7658 (FNAL/C–93/355-E) **A measurement of the W mass using electrons at CDF.** Saltzberg, D. (Chicago Univ., IL (United States). Enrico Fermi Inst.). CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9310247–2: 9. workshop on proton-antiproton collider physics, Tsukuba (Japan), 18-22 Oct 1993). Order Number DE94004656. Source: OSTI; NTIS; INIS; GPO Dep.

We present a preliminary measurement of the mass of the boson using electron data from the 1992-93 collider run at the Fermilab Tevatron. The result is Mw = 80.47 $\pm$ 0.15 (stat) $\pm$ 0.25 (syst.) GeV. Current predictions agree with this value.

7659 (IC–93/242) **Calculations on some properties of the pion in the framework of Schwinger-Dyson and Bethe-Salpeter equations.** Wan Shaolong (International Centre for Theoretical Physics, Trieste (Italy)); Wang Kelin. International Centre for Theoretical Physics, Trieste (Italy). Aug 1993. 28p. Order Number DE94611232. Source: OSTI; NTIS (US Sales Only); INIS.

A phenomenological potential model, the modified flat-bottom potential, is assumed according to the flat-bottom potential and some physical considerations for the infrared and ultraviolet asymptotic behaviours of the effective quark-gluon coupling. Then, the propagator functions and mass function for the quark, and the Bethe-Salpeter wave functions, mass, electromagnetic form factor, radius and decay constant for the pion are calculated numerically in the framework of the Schwinger-Dyson and Bethe-Salpeter equations with the modified flat-bottom potential. In order to obtain these, the Schwinger-Dyson and Bethe-Salpeter equations in the modified flat-bottom potential model are solved simultaneously by numerical iteration in the ladder approximation, and without any further one. Our results for the asymptotic quark mass function and the bound state wave functions agree with those derived from other theories and for the electromagnetic form factor, mass,

radius and decay constant of the pion agree with experimental results, respectively. (author). 14 refs, 9 figs.

7660 (IHEP-OTF–92-53) **Isoscalar vector bosons at LEP 2.** Gershtejn, S.S.; Likhoded, A.A.; Obraztsov, V.F.; Shevlyagin, M.V.; Yushchenko, O.P. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (Russian Federation). Inst. Fiziki Vysokikh Ehnergij. 1992. 18p. Order Number DE94611253. Source: OSTI; NTIS (US Sales Only); INIS.

The phenomenological manifestations of the additional $Y(Y_L)$ boson arising in the models with the composite structure of electroweak interactions are studied for the process $e^+e^- \rightarrow ff$-bar and $e^+e^- \rightarrow W^+W^-$ at the LEP 2 energies. It is shown that the inclusion of the additional isoscalar boson with the parameters providing the explanation of the TRISTAN data yields a measurable effect ($\approx$ tens of per cent) in the cross-section of $e^+e^- \rightarrow \mu^+\mu^-$ (hadrons) processes at energies $\sqrt{s}$=160-200 GeV. A contribution of the additional boson in the cross-section of the $e^+e^- \rightarrow W^+W^-$ process in negligible ($\leq$0.5%) at these energies. 19 refs.

7661 (INP-MSU–92-42-291) **Reconstruction of spectral density and gluon condensate fitting from the two-loop correction to the coefficient function.** Bajkov, P.A.; Il'in, V.A.; Smirnov, V.A. Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1992. 13p. (NIIYaF-MGU–92-42-291.). Order Number DE94611254. Source: OSTI; NTIS (US Sales Only); INIS.

The spectral density in the integral representation for the gluon condensate coefficient function up to two-loop level is constructed. Using this representation, the gluon condensate value (from charmonium spectroscopy experimental data) is re-estimated and concluded that this value is approximately two times greater than the one-loop effective value. 9 refs.

7662 (JINR-E–2-92-158) **Scaling effects and cross structure of baryon resonances spectrum.** Ratis, Yu.L.; Gareev, F.A. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 12p. Order Number DE94611226. Source: OSTI; NTIS (US Sales Only); INIS.

Simple arguments are given for the explanation of the gross structure of the spectrum of baryon resonances based on the scaling analysis. 20 refs.; 2 figs.; 3 tabs.

7663 (JINR-R–2-92-162) **Maxwell equations and Doppler effect for an electron.** Klenin, B.A. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Nuclear Reactions. 1992. 15p. (In Russian). Order Number DE94611246. Source: OSTI; NTIS (US Sales Only); INIS.

On the basis of the Maxwell equations for the elecromagnetic field in vacuum and the Newton-Lorentz equation of motion the Doppler effect for an electron is received, characterizing the electron wave properties, which results relativistic Lorentz transformations of the special relativity theory. 4 refs.

7664 (KFKI–1993-13/A) **Exotic heavy baryons at LHC.** Biro, T.S. (Giessen Univ. (Germany)); Zimanyi, J. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Jun 1993. 14p. Order Number DE94611227. Source: OSTI; NTIS (US Sales Only); INIS.

A heavy bottom-charm six-quark baryon is considered. A semiclassical and a Gaussian estimate show that the octet-octet bbb-ccc configuration can be favoured energetically rather than the singlet-singlet one. This result suggests that a confined bbb-ccc six-quark state may exist. Such objects may be produced in suitable amounts by heavy-ion collisions at Large Hadronic Collider energies. (R.P.) 8 refs. 1 fig.

7665 (SLAC-PUB–6316) **The $\Delta(1232)$ resonance transition form factor.** Staurt, L.M. (California Univ., Davis, CA (United States)); Bosted, P.E.; Lung, A. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1993. 4p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);United States-Israel Binational Science Foundation, Jerusalem (Israel). DOE Contract AC03-76SF00515 ; W-7405-ENG-48 ; FG02-88ER40415 ; AC02-76ER13065 ; FG06-90ER40537. Grants PHY-87-15050; 27; PHY–88-19259; PHY-86-581. (CONF-9306260–3: Conference on exclusive reactions at high momentum transfer, Elba (Italy), 24-26 Jun 1993). Order Number DE94003442. Source: OSTI; NTIS; INIS; GPO Dep.

Old and new measurements of inclusive e–p cross sections in the $\Delta(1232)$ resonance region have been combined, and a global data fit has been made. Using this fit to parameterize the nonresonant background, the transition form factors have been extracted out to a four-momentum transfer, Q^2, of 9.8 $(GeV/c)^2$. The results are systematically higher than those from a previous analysis, but agree within errors. A similar analysis has been done with e–d cross sections, and σ_n/σ_p in the $\Delta(1232)$ resonance region has been extracted out to a Q^2 of 7.9 $(GeV/c)^2$. σ_n/σ_p for $\Delta(1232)$ production is consistent with unity, while σ_n/σ_p for the nonresonant background is constant with Q^2 at approximately 0.4.

7666 (SLAC-PUB–6329) **Determination of the neutron spin-structure function.** Petratos, G.G. SLAC E-142 Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Oct 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-930637–13: 13. international conference on particles and nuclei, Perugia (Italy), 27 Jun - 3 jul 1993). Order Number DE94005234. Source: OSTI; NTIS; INIS; GPO Dep.

The neutron spin-structure function g_1^n has been determined by measuring the asymmetry in deep inelastic scattering of polarized electrons off a polarized ^{3}He target. The results are interpreted in the quark-parton model and used, in conjuction with earlier proton results, to test the Bjorken sum rule.

7667 (SLAC-PUB–6340) **High energy parton-parton elastic scattering in QCD.** Tang, W.K. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9306221–9: 19 international conference on elastic and diffractive scattering (5th Blois workshop), Providence, RI (United States), 8-12 Jun 1993). Order Number DE94003432. Source: OSTI; NTIS; INIS; GPO Dep.

We show that the high energy limit of quark-quark, or gluon-gluon, elastic scattering is calculable in terms of the BFKL pomeron when $-t \gg \Lambda_{QCD}^2$. Surprisingly, this on-shell amplitudes does not have infrared divergences in the high energy limit.

7668 (SLAC-PUB–6347) **Results on structure functions from fixed-target experiments.** Hughes, E. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Sep 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9306251–2: Conference on physics in collision, Heidelberg (Germany), 16-18 Jun 1993). Order Number DE94005233. Source: OSTI; NTIS; INIS; GPO Dep.

A review of proton and neutron structure function measurements fro fixed-target experiments is presented. Results on unpolarized structure functions have stabilized for $\chi > 0.1$, and new results on lower χ measurements are appearing. Recent results on the measurement of the neutron spin structure function are given and discussed in relation to previous surprising results from the proton spin structure function measurement.

7669 (SLAC-PUB–6354) **Energy distribution of the leptons in top decay to charged Higgs.** Pomarol, A. (California Univ., Santa Cruz, CA (United States). Inst. for Particle Physics); Schmidt, C.R. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Sep 1993. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9306176–22: Workshop on physics at current accelerators and the supercollider, Argonne, IL (United States), 2-5 Jun 1993). Order Number DE94005231. Source: OSTI; NTIS; INIS; GPO Dep.

We analyze the energy, distribution of the leptons coming from the top decay $t \rightarrow bH^+$, $bW^+ \rightarrow bl^+\nu$. The correlation between the lepton energy distribution and the top spin may be useful for distinguishing the H^+ signature from the W background. Such a correlation can also be useful for disentangling the two different $H^+\bar{t}b$ couplings and determining the experimental value of tan β.

6630 Nuclear Physics

Refer also to citation(s) 7561, 7564

7670 (DOE/ER/40314–7) **Research in nuclear physics: Progress report, 1992–1993.** Kozub, R.L.; Hindi, M.M. Tennessee Technological Univ., Cookeville, TN (United States). Dept. of Physics. Jun 1993. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-87ER40314. Order Number DE94004414. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the following topics: Search for Massive Neutrinos in the Recoil Spectrum of ^{37}Cl following Electron Capture Decay of ^{37}Ar; A Monte Carlo Simulation of the Electron Capture Decay of ^{37}Ar with an Admixture of Massive Neutrinos: Search for 17-keV Neutrinos in the Internal Bremsstrahlung Spectrum of ^{125}I; β^+ Decay and Cosmic-Ray Half-Lives of ^{143}Pm and ^{144}Pm; and Production Cross Sections from the Bombardment of Natural Mo with Protons.

7671 (DOE/ER/40425–258) **Theoretical nuclear physics: Progress report, July 1, 1992–June 30, 1993.** Koltun, D.S. Rochester Univ., NY (United States). Dept. of Physics and Astronomy. 30 Jun 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER40425. Order Number DE94004962. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes progress during the past year in the following areas of research: the role of meson exchange currents in nuclear reactions, including vector mesons in pion DCX, and K^+-nucleus cross sections. Pion excess distributions in nuclei, and the role of nuclear correlations. Inelastic electron scattering and the Coulomb sum rule. Statistical nuclear spectroscopy, including the evaluation of static densities and expectation values.

6631 Nuclear Structure

Refer also to citation(s) 7696, 7703, 7704, 7705, 7713, 7714, 7728, 7738

7672 (BNL–49621) **Recent results and directions in hypernuclear and Kaon physics.** May, M. Brookhaven National Lab., Upton, NY (United States). [1993]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-930637–12: 13. international conference on particles and nuclei, Perugia (Italy), 27 Jun - 3 jul 1993). Order Number DE94003991. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents recent data and future plans for experiments at Brookhaven National Laboratory on hypernuclei and related topics. It will discuss experiment which put a single strange quark in the nucleus and an experiment to produce nuclei containing two strange quarks ($\Lambda\Lambda$ hypernuclei).

7673 (CONF-9305314–1) **Investigation of giant resonances via photon decay.** Varner, R.L. (Oak Ridge National Lab., TN (United States)); Beene, J.R.; Bertrand, F.E. Oak Ridge National Lab., TN (United States). 1 Nov 1993. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 2. two-arm photon spectrometer (TAPS) workshop; Guardamar (Spain); 31 May - 5 jun 1993. Order Number DE94004795. Source: OSTI; NTIS; INIS; GPO Dep.

We describe some investigations into properties of giant resonances using elastic scattering of fast heavy-ion beams and the coincident detection of the gamma decay of the excited nucleus, using the TAPS array at GANIL. The particular experiments described are the identification of multiphoton giant resonance states and the measurement of projectile excitation, using the KVI forward wall detector.

7674 (CONF-9308199–1) **Nuclear structure at particle drip lines.** Dobaczewski, J. (Oak Ridge National Lab., TN (United States)); Hamamoto, I.; Nazarewicz, W.; Sheikh, J.A. Oak Ridge National Lab., TN (United States); Tennessee Univ., Knoxville, TN (United States); Vanderbilt Univ., Nashville, TN (United States). [1993]. 21p. Sponsored by USDOE, Washington, DC (United States);Polish State Committee for Scientific Research (Poland);Forskningsraadsnaemnden, Stockholm (Sweden). DOE Contract AC05-84OR21400 ; FG05-87ER40361 ; FG05-93ER40770. Contract 204509101. From 23. summer school on nuclear physics; Piaski (Poland); 18-28 Aug 1993. Order Number DE94004740. Source: OSTI; NTIS; INIS; GPO Dep.

Several examples of mean-field calculations, relevant to the recent and planned low-spin experimental works, are presented. The perspectives for future studies (mainly related to spectroscopy of exotic nuclei) are reviewed.

7675 (CONF-9309173–7) **Mean field approach to nuclear structure.** Nazarewicz, W. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States); Tennessee Univ., Knoxville, TN (United States). Dept. of Physics. [1993]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400 ; FG05-87ER40361 ; FG05-93ER40770. From Capture gamma-ray symposium; Fribourg (Switzerland); 20-24 Sep 1993. Order Number DE94003474. Source: OSTI; NTIS; INIS; GPO Dep.

Several examples of mean-field calculations, relevant to the recent and planned low-spin experimental works, are presented. The perspectives for future studies (mainly related to spectroscopy of exotic nuclei) are reviewed.

7676 (CONF-9309173–8) **Level repulsion, nuclear chaos, and conserved quantum numbers.** Garrett, J.D. Oak Ridge National Lab., TN (United States). [1993]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Capture gamma-ray symposium; Fribourg (Switzerland); 20-24 Sep 1993. Order Number DE94004248. Source: OSTI; NTIS; INIS; GPO Dep.

A statistical analysis of the distribution of level spacings for states with the same spin and parity is described in which the average spacing is calculated for the total ensemble. Though the resulting distribution of level spacings for states of deformed nuclei with Z = 62 - 75 and A = 155 - 185 is the closest to that of a Poisson distribution yet obtained for nuclear levels, significant deviations are observed for small level spacings. Many, but not all, of the very closely-spaced levels have K-values differing by several units. The analysis of level spacings in ^{157}Ho indicate that considerable caution should be excerised when drawing conclusions from such an analysis for a single deformed nucleus, since the sizable number of spacings that can be obtained from a few rotational bands are not all independent.

7677 (DOE/ER/40406–6) **Investigations of nuclear structure and nuclear reactions induced by complex projectiles: Progress report for the period September 1, 1992–August 31, 1993.** Sarantites, D.G. Washington Univ., St. Louis, MO (United States). Dept. of Chemistry. 6 Sep 1993. 112p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER40406. Order Number DE94004715. Source: OSTI; NTIS; INIS; GPO Dep.

This is a progress report on activities of the Washington University group in nuclear reaction studies for the period Sept 1, 1992 to Aug 31, 1993. This group has a research program which touches five areas of nuclear physics: nuclear structure studies at high spin; studies at the interface between structure and reactions; production and study of hot nuclei; reaction mechanism studies; development and use of novel techniques and instrumentation in the above areas of research. Specific activities of the group include in part: superdeformation in ^{82}Sr; structure of and identical bands in ^{182}Hg and ^{178}Pt; a highly deformed band in ^{136}Pm; particle decay of the ^{164}Yb compound nucleus; fusion reactions; proton evaporation; two-proton decay of ^{12}O; modeling and theoretical studies; excited ^{16}O disassembly into four alpha particles; ^{209}Bi + ^{136}Xe collisions at 28.2 MeV/amu; and development work on 4π solid angle gamma detectors, and x-ray detectors.

7678 (JINR-E–4-92-212) **Analysis of compound nucleus formation in reactions ^{100}+^{100}Mo and ^{110}Pd+^{110}Pd. Fusion barrier.** Antonenko, N.V. (Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics); Cherepanov, E.A.; Volkov, V.V.; Nasirov, A.K. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 22p. Order Number DE94611284. Source: OSTI; NTIS (US Sales Only); INIS.

The analysis of the evaporation residue cross sections in reactions $^{100}Mo+^{100}Mo$ and $^{110}Pd+^{110}Pd$ has been carried out within different models of fusion. 28 refs.; 9 figs.

7679 (JINR-E–4-92-542) **The widths of magnetic twist modes.** Molodtsova, I.V.; Bastrukov, S.I.; Shilov, V.M. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 10p. Order Number DE94611259. Source: OSTI; NTIS (US Sales Only); INIS.

Within the dissipative nuclear fluid-dynamics the predictions are presented for the widths of magnetic twist resonances associated with the long wavelength torsion like vibrations of a spherical nucleus. 25 refs.; 2 figs.; 1 tab.

7680 (JINR-R–4-92-165) **Giant dipole resonance with Skyrme forces.** Bal'butsev, E.B. (Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics); Unzhakova, A.V. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 7p. (In Russian). Order Number DE94611260. Source: OSTI; NTIS (US Sales Only); INIS.

The method of Wigner function moments is applied to calculate energies and excitation probabilities of giant dipole resonance with Skyrme forces. Good agreement with the experimental results is obtained. 9 refs.; 1 fig.

7681 (KFKI–1993-11/A, pp. 1-10) **New results of the Fritiof model and collective effects in nucleus collisions.** Gustafson, G. (Lund Univ. (Sweden). Dept. of Theoretical Physics). Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

The following two topics are discussed: First, the transverse momentum exchange for a hard parton-parton scattering must be larger than the $k_{perpendicular}$ for the associated gluon bremsstrahlung. This condition gives a dynamical cutoff for the hard parton scattering. It is implemented in a new Fritiof Monte Carlo which should be be applicable to hadron or nucleus collisions also at very high energies. Second, in collisions between large nuclei the strigs produced should interact with each other and not be fully independent. This will imply somewhat increased values of transverse energy, but a larger effect is expected for the size of the fragmentation region related to Bose-Einstein correlations. (author) 15 refs.; 22 figs.

7682 (ORNL/FTR–4678) **Travel to Denmark to participate in the Symposium on the Perspectives in Nuclear Structure and to Greece and Sweden to present Nuclear Spectroscopy: Foreign trip report, June 6–July 3, 1993.** Garrett, J.D. Oak Ridge National Lab., TN (United States). 14 Sep 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94000510. Source: OSTI; NTIS (US Sales Only); GPO Dep.

A brief summary of the activities of the traveler, information derived, and impressions gained while attending the Symposium on the Perspectives in Nuclear Structure, Copenhagen, Denmark, the Workshop on Nuclear Spectroscopy at the New Arrays, Lund, Sweden, and the Conference on the Future of Nuclear Structure, Aghia Pelaghia, Crete, Greece, as well as while visiting the Niels Bohr Institute, are described.

6632 Radioactivity and Electromagnetic Transitions (Excluding Fission)

Refer also to citation(s) 7533, 7673, 7687, 7693, 7698

7683 (FEI–2182) **Excitation of the reaction of ^{123}I, ^{123}Xe and ^{123}Cs radionuclides production: Experimantal and calculational data.** Dovbenko, A.G.; Kurenkov, N.V.; Lunev, V.P.; Malinin, A.B.; Masterov, V.S.; Shubin, Yu.N. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk (Russian Federation). Fiziko-Ehnergeticheskij Inst. 1991. 43p. (In Russian). Order Number DE94611293. Source: OSTI; NTIS (US Sales Only); INIS.

The results of calculations of charged particle induced reactions for the production of radioisotopes ^{123}I, ^{123}Cs, ^{123}Xe are discussed. The excitation functions for reactions $^{124}Xe(p,2n)$, $^{124}Xe(d,3n)$, $^{124}Xe(p,pn+np)$, $^{127}I(p,5n)$, $^{124}Xe(d,p2n)$, $^{123}Te(p,n)$, $^{124}Te(p,2n)$, $^{121}Sb(\alpha,2n)^{123}I$ are calculated on the base of statistical model in energy range up to 80 MeV. The agreement between the calculations and experiment is reasonable as a rule. It is shown, that taking account of the radiative channel is very important near threshold, particularly for neutron deficient nuclei. The analysis performed showed that the calculations with code ALICE can serve as a reasonable evaluation for the excitation functions of various reactions, if they are tested by experiment and by comparison of relevant computer codes. 55 refs.; 9 figs.; 10 tabs.

7684 (JINR-R–4-92-166) **Magnetic characteristics of collective states of isotopes $^{156,158,160,162,164}Dy$.** Mikhajlov, I.N. (Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics); Usmanov, P.N.; Okhunov, A.A.; Briancon, Ch.; Kulessa, R. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 10p. (In Russian). Order Number DE94611317. Source: OSTI; NTIS (US Sales Only); INIS.

WEithin the phenomenological model, which takes into account the Coriolis coupling of the ground bands, the influence of states of bands ion the magnetic characteristics of low-lying levels has been investigated. 18 refs.; 3 figs.; 4 tabs.

7685 (JINR-R–6-92-536) **Nonadiabaticies of monopole and quandrupole transitions in ^{156}Gd.** Gromov, K.Ya. (Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Nuclear Problems); Usmanov, P.N.; Kholmatov, A.Kh.; Butabaev, Yu.S.; Niyazov, R.A. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Nuclear Problems. 1992. 16p. (In Russian). Order Number DE94611318. Source: OSTI; NTIS (US Sales Only); INIS.

The theoretical analysis of positive parity states is carried out. Calculations in the framework of the phenomenological model taking into account the mixing of $K^n=0_1^+$, 0_2^+, 0_3^+, 2_1^+ and experimentally studied $K^n=1^+$-band states have been done. The values of monopole matrix element $\rho(E0)$ are estimated. 21 refs.; 2 figs.; 10 tabs.

7686 (PNL-SA–22707) **Simulated progress in double-beta decay.** Miley, H.S. (Pacific Northwest Lab., Richland, WA (United States)); Arthur, R.J.; Avignone, F.T. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9309296–1: Theory and phenomenology in astroparticle and underground physics conference, Gran Sasso (Italy), 19-23 Sep 1993). Order Number DE94004720. Source: OSTI; NTIS; INIS; GPO Dep.

A Monte Carlo code has been developed to accurately simulate double-beta decay measurements. Coincident gamma rays, beta spectra, and angular correlations have been added to adequately simulate a complete ^{100}Mo nuclear decay and provide corrections to experimentally determined detector efficiencies. This code has been used to strip certain low-background spectra obtained in the Homestake gold mine in Lead, SD, for the purpose of extremely sensitive materials assay for the construction of new, large, enriched germanium detectors. Assays as low as 9 μBq/g of ^{210}Pb in lead shielding were obtained.

6633 Nuclear Reactions and Scattering, General

Refer also to citation(s) 7653

7687 (JINR-R–2-92-154) **The bremmstrahlung as the method investigation of the elastic scattering mechanism.** Lyuboshits, V.L.; Podgoretskij, M.I. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of High Energy. 1992. 18p. (In Russian). Order Number DE94611324. Source: OSTI; NTIS (US Sales Only); INIS.

The bremsstrahlung spectrum of gamma-radiation created by the scattering through the intermediate long-living state is discussed. 20 refs.

6634 Specific Nuclear Reactions and Scattering

Refer also to citation(s) 7309, 7320, 7555, 7592, 7601, 7607, 7613, 7615, 7622, 7646, 7664, 7666, 7673, 7677, 7678, 7681

7688 (ANL/EP/CP–81421) **Production of ^{99}Mo using LEU and molybdenum targets in a 1 MW Triga reactor.** Mo, S.C. Argonne National Lab., IL (United States). [1993]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9310185–5: 16. international meeting on reduced enrichment for research and test reactors (RERTR), Ibaraki (Japan), 3-7 Oct 1993). Order Number DE94004621. Source: OSTI; NTIS; INIS; GPO Dep.

The production of ^{99}Mo using Low Enriched Uranium (LEU) and natural molybdenum targets in a 1 MW Triga reactor is investigated. The successive linear programming technique is applied to minimize the target loadings for different yield constraints. The irradiation time is related to the kinetics of the growth and decay of ^{99}Mo. The feasibility of a neutron generated based ^{99}Mo production system is discussed.

7689 (ANL/NDM–131) **Fast-neutron scattering from vibrational palladium nuclei.** Smith, A.B. (Argonne National Lab., IL (United States)); Guenther, P.T. Argonne National Lab., IL (United States). Oct 1993. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94005258. Source: OSTI; NTIS; INIS; GPO Dep.

Neutron total cross sections of elemental palladium are measured from ≈0.6–4.5 MeV. These results, combined with others previously reported from this laboratory, provide a detailed knowledge of the neutron total cross sections of palladium from ≈0.1–20 MeV. Differential neutron elastic-scattering cross sections are measured from ≈1.5–10 MeV in sufficient energy and angle detail to well define the energy-average behavior. Concurrently, neutron inelastic-scattering cross sections are measured from ≈1.5–8 MeV. Inelastically-scattered neutron groups are observed corresponding to excitations of: 306 ± 14, 411 ± 47, ≈494, 791 ± 20, 924 ± 20, 1,156 ± 24, 1,358 ± 35, 1,554 ± 47 and 1,706 ± 59 keV, with additional tentative groups at 1,938 and 2,059 keV. Particular attention is given to the inelastic excitation of the 2^+ yrast states of the even isotopes. This broad data base is examined in the context of optical-statistical and coupled-channels models. The resulting model parameters are consistent with systematic trends in this vibrational mass region previously noted at this laboratory, and provide a suitable vehicle for many applications.

7690 (BNL–49626) **High baryon density from relativistic heavy ion collisions.** Pang, Y. (Brookhaven National Lab., Upton, NY (United States)); Kahana, S.H.; Schlagel, T.J. Brookhaven National Lab., Upton, NY (United States); State Univ. of New York, Stony Brook, NY (United States). Oct 1993. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016 ; FG02-93ER40768. (CONF-9305282–2: Particle physics at the fermi scale workshop, Beijing (China), 27 May - 4 jun 1993). Order Number DE94003894. Source: OSTI; NTIS; INIS; GPO Dep.

A quantitative model, based on hadronic physics, is developed and applied to heavy ion collisions at BNL-AGS energies. This model is in excellent agreement with observed particle spectra in heavy ion collisions using Si beams, where baryon densities of three and four times the normal nuclear matter density (ρ_0) are reached. For Au on Au collisions, the authors predict the formation of matter at very high densities (up to 10 ρ_0).

7691 (CEA-CONF–11409) **Characterization of highly charged ions by secondary electron emission.** Delaunay, M. CEA Centre d'Etudes de Grenoble, 38 (France). Dept. de Recherche Fondamentale sur la Matiere Condensee. 1993. 13p. (CONF-9305239–: 11. international workshop on electron resonance ion sources, Groningen (Netherlands), 5-8 May 1993). Order Number DE94611370. Source: OSTI; NTIS (US Sales Only); INIS.

The secondary electron emission yield from a metal surface bombarded by highly charged ions is measured to determine the ratio of different ions whose (q/m) are identical and therefore cannot be selected by a magnetic spectrometer. For impact of Ar^{q+} ions ($4 \leq q \leq 14$) and Ne^{q+} ions ($4 \leq q \leq 9$), the total yields of secondary electrons appear to be linearly proportional to q^2. Thus the electron emission for the neutralization of $^{40}Ar^{16+}$ can be estimated and the ion current ratio $^{40}Ar^{16+}/^{15}N^{6+}$ is determined. (author).

7692 (CONF-9210121–, pp. 5-16) **Prototypical experiments in nuclear astrophysics.** Champagne, A.E. (Univ. of North Carolina, Chapel Hill, NC (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory*. 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

During explosive nucleosynthesis, temperatures are on the order of (0.2 - 1.5) x 10^9 K and average densities can be 10^3 - 10^6 g/cm^3. Under these extreme conditions, nuclear reactions will proceed on timescales of ns - min (though more typically sec - min). Thus any nuclei produced with comparable half lives will become targets for subsequent nuclear reactions. Measurements of at least some of these reactions are desirable, both from an astrophysical and from a nucleosynthetic perspective: Cataclysmic binaries are powered by these reactions and so a knowledge of their rates is crucial to an understanding of the outburst mechanism. Astrophysicists are also interested in elemental abundances, particularly of spectroscopic tracers such as ^{22}Na, ^{26}Al and ^{44}Ti. In type II supernovae, these reactions are incidental to the outburst, but again nucleosynthesis can provide clues as to the physical conditions during an explosion. To be very general, these reactions will have both large cross sections and small cross sections. The former reactions are important for energy generation and in principle they can be measured directly with radioactive beams. The latter reactions limit power output and play a role in the production of the trace elements which could be used as spectroscopic probes. Here direct measurements are probably impractical, but nuclear spectroscopy, involving both stable and radioactive beams, can provide the desired information.

7693 (CONF-9210121–, pp. 17-33) **High-spin nuclear structure studies with radioactive ion beams.** Baktash, C. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. DOE Contract AC05-84OR21400. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory*. 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

Two important developments in the sixties, namely the advent of heavy-ion accelerators and fabrication of Ge detectors, opened the way for the experimental studies of nuclear properties at high angular momentum. Addition of a new degree of freedom, namely spin, made it possible to observe such fascinating phenomena as occurrences and coexistence of a variety of novel shapes, rise, fall and occasionally rebirth of nuclear collectivity, and disappearance of pairing correlations. Today, with the promise of development of radioactive ion beams (RIB) and construction of the third-generation Ge-detection systems (GAMMASPHERE and EUROBALL), nuclear physicists are poised to explore new and equally fascinating phenomena that have been hitherto inaccessible. With the addition of yet another dimension, namely the isospin, they will be able to observe and verify predictions for exotic shapes as varied as rigid triaxiality, hyperdeformation and triaxial-octupole shapes, or to investigate the T=O pairing correlations. In this paper, the author reviews, separately for neutron-deficient and neutron-rich nuclei, these and a few other new high-spin physics opportunities that may be realized with RIB. Following this discussion, a list of the beam species, intensities and energies that are needed to fulfill these goals is presented. The paper concludes with a description of the experimental techniques and instrumentations that are required for these studies.

7694 (CONF-9210121–, pp. 35-49) **Study of nuclear reactions at an ISL facility.** Becchetti, F.D. (Univ. of Michigan, Ann Arbor, MI (United States)). Oak Ridge National Lab., TN (United

States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

Researchers are entering an exciting period of nuclear science. As discussed in the previous ISL "white paper" the severe constraints imposed by using stable beams, (i.e. those which typically have N $\approx$ Z, are in the g.s., have zero or low spin, and are close to spherical) can be removed by the use of unstable nuclear beams (RIB/RNB). Thus in many ways, researchers are starting a new in nuclear physics. Obviously they do not want to just repeat 80 years of nuclear science but, instead, should concentrate on the new information that can be realized using RIB/RNB. Although study of reactions related to nuclear astrophysics will certainly play a significant role at ISL, nuclear astrophysics alone should not dictate the operating parameters. It now appears that much of the needed astrophysics-related data can be obtained from high-energy RIB/RNB reactions. As an example breakup information can be used in lieu of low energy (p,γ) or (n,γ) data. Also some of the most significant results may well come in non-astrophysics related experiments. (Of course, almost all of nuclear science is related to astrophysics in some way).

7695 (CONF-9210121–, pp. 51-63) **Prototypical experiments: Proton-rich nuclei reaction studies with inverse kinematics.** Hardy, J.C. (Chalk River Laboratories, Chalk River, Ontario (Canada)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

Several prototypical experiments are described which exploit single- and two-nucleon transfer as well as charge-exchange reactions - all in inverse kinematics - to study nuclear spectroscopy. The examples chosen relate to the N~Z nuclei with $56 \leq A \leq 100$ and to the study of superallowed β decay, but the potential usefulness of these reactions extends far beyond. It is concluded, however, that this rich potential can only be tapped at a future radioactive-beam facility if the beam energies reach at least 25 MeV/u and preferably 50 MeV/u.

7696 (CONF-9210121–, pp. 65-82) **Prototypical experiments: Neutron-rich nuclei.** Kratz, K.L. (Universitaet Mainz (Germany)); Moeller, P.; Thielemann, F.K. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. Grant DFG (Kr 806/1); Grant BMFT (06 MZ 106); Grant GSI (MZ Kra From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

In this paper the authors focus on the strong interplay between nuclear-structure properties of neutron-rich nuclei far from stability and stellar nucleosynthesis of elements beyond Fe by rapid neutron-capture processes. In the past, at several stages in the development of an understanding of the *r*-process mechanisms, the major limitation to further progress has been - and still is - the degree to which the associated nuclear physics is known. Therefore, it is no surprise that even today the exact stellar site of the r-process ('where in a supernova?') is not known. With the close connection between not only gross but also detailed microscopic nuclear physics and whatever constraints can be imposed on models for the astrophysical environments, it is obvious that only additional and more accurate experimental data on exotic neutron-rich isotopes can lead to a better understanding of r-process nucleosynthesis. An interesting recent finding in this context is that with the present knowledge of nuclear physics, of isotopic r-process abundances in nature, and of supernova models, deficiencies in calculated abundance patterns seem to indicate nuclear-structure effects on the very-neutron-rich side of β-stability for nuclei so far not observable in terrestrial laboratories. With the expected improvement in the production of far-unstable species at future ISOL and RIB facilities, unique opportunities will be provided not only to answer questions on fundamental current nuclear-structure themes, but also to allow the study of new phenomena, obviously derivable from astrophysical 'observations' but not from present nuclear-model extrapolations.

7697 (CONF-9210121–, pp. 105-127) **Report from discussion group on experiments with radioactive beams.** Vieira, D.J. (Los Alamos National Lab., NM (United States)); Wiescher, M. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

During the course of the workshop, a wide range of futuristic radioactive-beam experiments were discussed. These extended from the study of electroweak interactions in nuclei to materials science, nuclear astrophysics, and a host of nuclear physics investigations. Emphasis was placed on illustrating how these prototypical experiments could be accomplished, discussing what types of detection systems would be needed, exploring the new problems that would confront the radioactive-beam experimenter, and better defining the beam requirements.

7698 (CONF-9210121–, pp. 137-140) **Beta-delayed (alpha) particle emission; A probe of weak interactions in nuclei.** Gai, M. (Yale Univ., New Haven, CT (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

The authors propose proto-typical experiments for the Iso-Spin Laboratory: measurement of the beta-delayed alpha-particle emissions of ^{20}F and ^{20}Na with an estimated branching ratio of the order of 10^{-6}, to study rank one first forbidden beta decay of mirror nuclei, and the beta-delayed alpha-particle emission of ^{18}N with an estimated branching ratio of 10^{-10}, to study parity violation in ^{18}O. These experiments are natural extensions of the Yale experiment that measured the beta-delayed alpha-particle emission of ^{16}N, with a sensitivity for the branching ratio in the range of 10^{-9} to 10^{-10}. These experiments will utilize the high intensity secondary (radioactive) beams of the IsoSpin Laboratory, but will not require post acceleration.

7699 (CONF-9210121–, pp. 151-153) **A new region for fission and fission isomer studies.** Wilhelmy, J.B. (Los Alamos National Lab., NM (United States)); Moeller, P. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

An IsoSpin Laboratory would offer a unique opportunity to greatly extend the knowledge of the fission process. Near barrier studies of fission have been largely limited to a relatively narrow region of actinides (Th-Cf). Over the past decade the most exciting areas of fission studies have been associated with the very heaviest elements where rapidly changing barrier and shell properties have resulted in strong variations in mass distributions and kinetic energy release. These areas are, however, extremelly difficult to access and only limited quantities of data have been obtained. With an ISL facility it will be possible to produce copious quantities of previously inaccessible isotopes (due to a lack of any stable or long lived targets) in the region between Pb and Th. Using the ISL prototypical

design it is estimated that over 300 isotopes will be produced in the Pb-Th region having beam intensities > 10^6 particles/sec.

7700 (CONF-9210121–, pp. 155-158) **Production of beams of nuclei far from stability.** Boyd, R.N. (Ohio State Univ., Columbus, OH (United States)); Wiescher, M.C. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

A scheme is considered for producing extremely neutron rich nuclides in which a secondary radioactive nuclear beam is accelerated and fragmented to produce the (tertiary) beams of interest. Although little is known about some of the cross sections, the scheme appears sufficiently promising to warrant further investigation.

7701 (CONF-9210121–, pp. 159-162) **Rp-Process measurements with high-intensity RNBs.** Goerres, J. (Univ. of Notre Dame, Notre Dame, IN (United States)). Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

The author has calculated the reaction yields of several reactions of importance to the study of the rp process. The reactions considered are $^{19}Ne(p,\gamma)$, $^{31}S(p,\gamma)$, $^{39}Ca(p,\gamma)$, and $^{56}Ni(p,\gamma)$. By comparison with the recently measured reaction $^{13}N(p,\gamma)$, the yields are down by at least two orders of magnitude. Experimental measurement of these yield rates will require good beam intensity, and improved background reduction.

7702 (CONF-9210121–, pp. 163-166) **Samples for s- and p-process studies.** Kaeppeler, F. (Univ. of Karlsruhe, Karlsruhe (Germany)); Wiescher, M.; Koehler, P.E. Oak Ridge National Lab., TN (United States); Oak Ridge Inst. for Science and Education, TN (United States). [1992]. From Workshop on the production and use of intense radioactive ion beams for the IsoSpin Laboratory; Oak Ridge, TN (United States); 7-10 Oct 1992. In *Proceedings of the workshop on the production and use of intense radioactive beams at the Isospin Laboratory.* 442p. Order Number DE94000630. Source: OSTI; NTIS; INIS; GPO Dep.

This paper discusses the need for more experimental information with regard to the study of the s process, and the p process in stellar nucleosynthesis. In particular the need for stellar (n,γ) cross sections is considered. For unstable isotopes this need is the greatest at present. Because of experimental problems with neutron capture, these experiments appear to require off-line setups. That means the preparation of samples which are isotopically separated. Assuming conservative production rates, and limiting the selection to cases where the target half-life is much greater than the product half-life, and $E_\gamma < E_\gamma$, for the sake of detection, the authors have selected a group of potential isotopes for study: ^{134}Cs, ^{135}Cs, ^{137}Cs, ^{147}Nd, ^{147}Pm, ^{148}Pm, ^{154}Eu, ^{155}Eu, ^{163}Ho, ^{169}Er, ^{170}Tm, ^{171}Tm, and ^{179}Ta.

7703 (CONF-9305293–3) **The future radioactive ion beam research program at Oak Ridge.** Ball, J.B. Oak Ridge National Lab., TN (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From International symposium on nuclear structure physics today; Taiwan (China); 11-14 May 1993. Order Number DE94002784. Source: OSTI; NTIS; GPO Dep.

Early in 1995, the ORNL Holifield Facility is scheduled to return to operation as a dedicated radioactive ion beam (RIB) facility. This enhanced capability will open up new possibilities for research on the structure of and phenomena occurring in proton-rich nuclei. Among the opportunities will be the creation of heavier N~Z nuclei, approaching ^{100}Sn, and the study of exotic nuclear shapes, extensions of studies of the p-n interaction and super-allowed beta decay, and examination of nuclear structure near the proton drip line. In addition to new nuclear and atomic physics research opportunities, the beams from the Holifield RIB facility are expected to provide new capabilities for measurements important to nuclear astrophysics. To carry out this experimental program, various upgrades are planned to the existing experimental apparatus, and a new, third-generation, recoil-mass separator is being constructed.

7704 (CONF-930867–4) **Heavy Ion Coulomb excitation and gamma decay studies of the one and two phonon giant dipole resonances in ^{208}Pb and ^{209}Bi.** Mueller, P.E. (and others); Beene, J.R.; Bertrand, F.E. Oak Ridge National Lab., TN (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC05-84OR21400. From Gull Lake nuclear physics conference on giant resonances; Gull Lake, MI (United States); 17-21 Aug 1993. Order Number DE94003473. Source: OSTI; NTIS; INIS; GPO Dep.

Projectile – photon coincidences were measured for the scattering of an 80 MeV/nucleon ^{64}Zn beam from ^{208}Pb and ^{209}Bi targets at the GANIL heavy ion accelerator facility. Projectile-like particles between 0.5° and 4.5° relative to the incident beam direction were detected in the SPEG energy loss spectrometer where their momentum, charge, and mass were determined. Photons were detected in the BaF_2 scintillation detector array TAPS. Light charged particles produced in the reaction were detected in the KVI Forward Wall. The analysis of the data acquired in this experiment is focused on three different phenomena: (1) the two phonon giant dipole resonance, (2) time dependence of the decay of the one phonon giant dipole resonance, and (3) giant resonance strength in projectile nuclei.

7705 (CONF-9311139–1) **Experimental and theoretical nuclear data work at ORELA.** Larson, D.C. Oak Ridge National Lab., TN (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 1993 symposium on nuclear data; Tokai (Japan); 18-19 Nov 1993. Order Number DE94004246. Source: OSTI; NTIS; INIS; GPO Dep.

The Oak Ridge Electron Linear Accelerator (ORELA) passed the 100,000 hours of operation milestone in October, 1992, and continues to operate as an intense, pulsed neutron source. In addition to performing measurements of interest to applied and basic research, they are involved in international nuclear data evaluation activities, as well as nuclear model code development. The intense, slow-positron source attached to ORELA continues to attract interest from industry, and a new photon activation facility added this last year is also being used for basic research and by industry. The author describes some of the above activities.

7706 (DOE/ER/40281–8) **[Relativistic heavy ion research]: [Annual report for 15 November 1992–14 November 1993].** Nagamiya, S. Columbia Univ., New York, NY (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER40281. Order Number DE94004701. Source: OSTI; NTIS; INIS; GPO Dep.

This progress report describes the participation of members of the Nevis group in different experiments during the FY93 period. There was major involvement in: BNL/AGS experiment E802/859/866; BNL RHIC experiment PHENIX; and CERN/SPS experiment NA44. The group was also involved in the small scale experiment E858/878 at BNL/AGS. For the BNL/AGS experiment data collection is now complete, and the group is involved in data analysis. Contributions to systematic procedures for measuring and maintaining the high calibration of the time-of-flight system, along with the previously developed trigger system have been significant contributions to the physics which is beginning to emerge from this heavy ion experiment. The CERN experiment has published first results on S-Pb collisions, with emphasis on two particle correlations. The group has been actively involved in data collection this year. Emphasis is being placed on proton-proton interactions in S-Pb and proton-Pb collisions. The PHENIX experiment is aimed at measuring signatures of quark-gluon plasma. The Nevis group has been actively involved in this experiment from design of the time-of-flight and trigger system, to acting as experiment spokesman.

7707 (DOE/ER/40316–7) **Studies of complex fragment emission in heavy ion reactions: Progress report, January 1, 1993–September 15, 1993.** Charity, R.J.; Sobotka, L.G. Washington Univ., St. Louis, MO (United States). 12 Sep 1993. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-87ER40316. Order Number DE94001309. Source: OSTI; NTIS; INIS; GPO Dep.

The study of intermediate-energy heavy-ion nuclear reactions is reported. This work has two foci: the properties of nuclear matter under abnormal conditions, in this energy domain, predominately low densities and the study of the relevant reaction mechanisms. Nuclear matter properties, such as phase transitions, are reflected in the dynamics of the reactions. The process leads to an understanding of the reaction mechanism themselves and therefore to the response characteristics of finite, perhaps non-equilibrium, strongly interacting systems. The program has the following objectives: to study energy, mass, and angular momentum deposition by studying incomplete fusion reactions; to gain confidence in the understanding of how highly excited systems decompose by studying all emissions from the highly excited systems; to push these kinds of studies into the intermediate energy domain (where intermediate mass fragment emission is not improbable) with excitation function studies; and to learn about the dynamics of the decays using particle-particle correlations. The last effort focuses on simple systems, where definitive statements are possible. These avenues of research share a common theme, large complex fragment production. It is this feature, more than any other, which distinguishes the intermediate energy domain.

7708 (DOE/ER/40342–6) **Colorado School of Mines low energy nuclear physics project: Final technical progress report.** Cecil, F.E. Colorado School of Mines, Golden, CO (United States). Dept. of Physics. 23 Nov 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-87ER40342. Order Number DE94004851. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes the accomplishments of the project "Studies of nuclear reactions at very low energies". This project was undertaken in 1987 and completed in 1993. All but one of the major objectives of this study have been accomplished. Specifically the authors have completed their investigation of the (p,γ) on light nuclei, a study of the Oppenheimer-Phillips effect, a measurements of the astrophysically interesting reaction $D(\alpha,\gamma)^6Li$ at low energies and an extension of the reaction $D(d,\gamma)^4He$ to lower energies than previously observed. Preliminary investigation of te reaction $^7Li(^3He,p)^9Be$ was begun and is continuing under a separate DOE grant. In addition to these tasks, they have completed some very interesting projects which were not included in the original proposal. These include a study of the (d,γ) reactions on ^6Li, ^7Li and ^{10}B and an investigation of the possibility of observing terrestrial antineutrinos from the beta decay chains of U and Th as a diagnostic of terrestrial heat flow.

7709 (DOE/ER/40402–6) **Oregon State University nuclear chemistry progress report, August 1, 1992–July 1, 1993.** Loveland, W. Oregon State Univ., Corvallis, OR (United States). Jul 1993. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-88ER40402. Order Number DE94001585. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the following topics related to nuclear chemistry: Element 110; synthesis of heavy nuclei with complete fusion reactions involving radioactive nuclear beams; the interaction of 21–44 MeV/nucleon Xe with Au; MeV/nucleon ^{86}Kr with ^{197}Au; intermediate energy Ar-Th collisions; target-like fragments from the interaction of 29 MeV/nucleon ^{208}Pb with ^{197}Au; the intermediate of 22 and 32 MeV/nucleon ^{16}O with ^{197}Au; Au projectile fragmentation at 20 MeV/nucleon; relativistic heavy ion research; and pulse height defect measurements for very heavy ions.

7710 (DOE/ER/40404–5) **Nuclear chemistry progress report.** Viola, V.E.; Kwiatkowski, K. Indiana Univ., Bloomington, IN (United States). Aug 1993. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER40404. Order Number DE94004716. Source: OSTI; NTIS; INIS; GPO Dep.

This is the annual progress report for the Indiana University nuclear chemistry program for the 1992/1993 year. Accomplishments include the construction, testing, and initial experimental runs of the Indiana Silicon Sphere (ISiS) 4π charged particle detector. ISiS is designed to study energy dissipation and multifragmentation phenomena in light-ion-induced nuclear reactions at medium-to-high energies. Its second test run was to examine 3.6 GeV ^3He beam reactions at Laboratoire National Saturne (LNS) in Saclay. The development and deployment of this system has occupied a great deal of the groups effort this reporting period. Additional work includes: calculations of isotopic IMF yields in the $^4He + ^{116,124}Sn$ reaction; cross sections for A = 6 - 30 fragments from the $^4He + ^{28}Si$ reaction at 117 and 198 MeV; charging effects of passivated silicon detectors; neck emission of intermediate-mass fragments in the fission of hot heavy nuclei.

7711 (DOE/ER/40414–6) **Studies of heavy-ion reactions and transuranic nuclei: Progress report, September 1, 1992–August 31, 1993.** Schroeder, W.U. Rochester Univ., NY (United States). Aug 1993. 353p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER40414. Order Number DE94004642. Source: OSTI; NTIS; INIS; GPO Dep.

This report contain papers on the following topics: The Cold-Fusion Saga; Decay Patterns of Dysprosium Nuclei Produced in $^{32}S + ^{118,124}Sn$ Fusion Reactions; Unexpected Features of Reactions Between Very Heavy Ions at Intermediate Bombarding Energies; Correlations Between Neutrons and Charged Products from the Dissipative Reaction $^{197}Au+^{208}Pb$ at E/A = 29 MeV; Dissipative Dynamics of Projectile-Like Fragment Production in the Reaction $^{209}Bi+^{136}Xe$ at E/A = 28.2 MeV; Dynamical Production of Intermediate-Mass Fragments in Peripheral $^{209}Bi+^{136}Xe$ Collisions at E_{lab}/A = 28.2 MeV; The Rochester 960-Liter Neutron Multiplicity Meter; A Simple Pulse Processing Concept for a Low-Cost Pulse-Shape-Based Particle Identification; A One-Transistor Preamplifier for PMT Anode Signals; A Five-Channel Multistop TDC/Event Handler for the SuperBall Neutron Multiplicity Meter; Construction of the SuperBall – a 16,000-Liter Neutron Detector for Calorimetric Studies of Intermediate-Energy Heavy-Ion Reactions; A Computer Code for Light Detection Efficiency Calculations for Photomultipliers of a Neutron Detector; Evaluation of Gd-Loaded Liquid Scintillators for the SuperBall Neutron Calorimeter; and Measurement of the Interaction of Cosmic-Ray μ^- with a Muon Telescope.

7712 (DOE/ER/40427–15-N93) **Color transparency.** Jennings, B.K. (TRIUMF, Vancouver, BC (Canada)); Miller, G.A. Washington Univ., Seattle, WA (United States). Dept. of Physics. [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-88ER40427. (CONF-9306260–2: Conference on exclusive reactions at high momentum transfer, Elba (Italy), 24-26 Jun 1993). Order Number DE94002725. Source: OSTI; NTIS; INIS; GPO Dep.

The anomously large transmission of nucleons through a nucleus following a hard collision is explored. This effect, known as color transparency, is believed to be a prediction of QCD. The necessary conditions for its occurrence and the effects that must be included a realistic calculation are discussed.

7713 (DOE/ER/40442–6) **Studies of nuclear processes: Progress report, 1 September 1992–31 August 1993.** Ludwig, E.J. Triangle Universities Nuclear Lab., Durham, NC (United States). 1 Sep 1993. 199p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-88ER40442 ; FG05-91ER40619 ; FG05-88ER40441. Order Number DE94002470. Source: OSTI; NTIS; INIS; GPO Dep.

Results for the period 1 Sep 92 through 31 Aug 93 are presented in nearly a hundred brief papers, some of which present new but preliminary data. Activities reported may be grouped as follows: Fundamental symmetries in the nucleus (parity-mixing measurements, time reversal invariance measurements, signatures of quantum chaos in nuclei), Internucleon reactions (neutron – proton interactions, the neutron – neutron scattering length, reactions between deuterons and very light nuclei), Dynamics of very light nuclei (measurements of D states of very light nuclei by transfer reactions, nuclear reactions between very light nuclei, radiative capture reactions with polarized sources), The many-nucleon problem (nuclear astrophysics, high-spin spectroscopy and superdeformation, the nuclear mean field: Dispersive relations and nucleon scattering, configuration mixing in ^{56}Co and ^{46}Sc using

(d,α) reactions, radiative capture studies, high energy resolution resonance studies at 100–400 keV, nuclear data evaluation for A=3–20), Nuclear instruments and methods (FN tandem accelerator operation, KN accelerator operation and maintenance, atomic beam polarized ion source, development of techniques for determining the concentration of SF_6 in the accelerator insulating gas mixture, production of beams and targets, detector systems, updating of TeX, Psprint, and associated programs on the VAX cluster), and Educational Activities.

7714 (DOE/ER/40537–31) **Shape changes and isospin purity in highly excited light mass nuclei.** Kicinska-Habior, M. (Warsaw Univ. (Poland)); Snover, K.A.; Behr, J.A.; Gossett, C.A.; Gundlach, J.H.; Drebi, Z.M.; Kaplan, M.S.; Wells, D.P. Washington Univ., Seattle, WA (United States). Nuclear Physics Lab. [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-90ER40537. (CONF-930867–2: Gull Lake nuclear physics conference on giant resonances, Gull Lake, MI (United States), 17-21 Aug 1993). Order Number DE94002317. Source: OSTI; NTIS; INIS; GPO Dep.

The statistical decay of the Giant Dipole Resonance built on a highly excited states of light-mass nuclei was studied in inclusive experiments. Results of the search for a shape change of hot, fast-rotating ^{45}Sc and the test of the isospin purity at high excitation in ^{28}Si and ^{26}Al are reported.

7715 (DOE/ER/40692–2) **Relativistic heavy ion physics: Progress report, November 15, 1992–November 14, 1993.** Hill, J.C.; Wohn, F.K. Iowa State Univ. of Science and Technology, Ames, IA (United States). Dept. of Physics and Astronomy. [1993]. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER40692. Order Number DE94003161. Source: OSTI; NTIS; INIS; GPO Dep.

This is a progress report for the period May 1992 through April 1993. The first section, entitled "Purpose and Trends, gives background on the recent trends in the research program and its evolution from an emphasis on nuclear structure physics to its present emphasis on relativistic heavy ion and RHIC physics. The next section, entitled "Physics Research Progress", is divided into four parts: participation in the program to develop a large detector named PHENIX for the RHIC accelerator; joining E864 at the AGS accelerator and the role in that experiment; progress made in the study of electromagnetic dissociation highlight of this endeavor is an experiment carried out with the ^{197}Au beam from the AGS accelerator in April 1992; progress in completion of the nuclear structure studies. In the final section a list of publications, invited talks, and contributed talks is given.

7716 (DOE/ER/40756–1) **Theoretical and computational studies in intermediate energy nuclear physics: Progress report, November 1, 1992–October 31, 1993.** Elster, C. Ohio Univ., Athens, OH (United States). Dept. of Physics and Astronomy. Aug 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-93ER40756. Order Number DE94004177. Source: OSTI; NTIS; INIS; GPO Dep.

The research includes applications of many-body scattering theory to nuclear systems and studies of few-body systems described by effective hadronic field theories. Progress was made in bringing all first-order effects into the nonrelativistic elastic nucleon-nucleus scattering in a consistent fashion. This work is directed towards completely and reliably calculating the first-order term in a Watson expansion including a modification through the nulear medium. The research effort in few-body physics was concentrated on nucleon-nucleon (NN) scattering below pion production threshold, where recent measurements indicated that the backward-angle neutron-proton (np) differential cross section may show sensitivity to the size of the pion-nucleon coupling constant.

7717 (INP-MSU–92-35-284) **Effective number of inelastically interacting nucleons in rare nucleus-nucleus production processes.** Korotkikh, V.L.; Lokhtin, I.P. Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1992. 19p. (NIIYaF-MGU–92-35-284.). Order Number DE94611371. Source: OSTI; NTIS (US Sales Only); INIS.

A model of nucleus-nucleus interaction using one inelastic NN-interaction is suggested for the exclusive production processes with small cross-section. A-dependence nuclear coherent and incoherent production cross-section are predicted. 20 refs.; 4 figs.

7718 (JINR-R–2-92-170) **Deep-inelastic operators in meson-nucleon theory.** Kazakov, K.Yu. (Dal'nevostochnyj Gosudarstvennyj Univ., Vladivostok (Russian Federation)); Umnikov, A.Yu.; Kaptar', L.P. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Theoretical Physics. 1992. 19p. (In Russian). Order Number DE94611341. Source: OSTI; NTIS (US Sales Only); INIS.

A nonrelativistic meson-nucleon theory of deep-inelastic scattering (DIS) of leptons of the deuteron is considered. 28 refs.; 2 figs.

7719 (KFKI–1993-11/A) **Proceedings of the Budapest workshop on relativistic heavy ion collisions.** Csoergoe, T.; Hegyi, S.; Levai, P. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. 149p. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

This volume is the Proceedings of the Budapest workshop on relativistic heavy ion collisions held in Budapest, 10-13 Aug, 1992. The topics include experimental heavy ion physics, Bose-Einstein correlations, intermittency, relativistic transport theory, Quark-Gluon Plasma rehadronization, astronuclear physics and cosmology. All contributions were indexed and abstracted. (author).

7720 (KFKI–1993-11/A, pp. 11-14) **Stopping power for large nuclei at very high energies.** Schoenfeld, Th. (Frankfurt Univ. (Germany). Inst. fuer Theoretische Physik); Stoecker, H.; Greiner, W.; Sorge, H. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

The microscopic phase space approach of Relativistic Quantum Molecular Dynamics (RQMD) is used to investigate the stopping power of very heavy nuclei at very high energies. No gap has been found in the rapidity distribution around mid-rapidity even at RHIC energies ($\sqrt{s}$=200 AGeV), but strong filling of the mid rapidity region was found. Neither is there a broad plateau for secondaries nor are the correlations between space-time and momentum as strong as in the Bjorken-McLarren scenario. This renders the Bjorken picture questionable at these energies for systems of combined mass A>400. (author) 20 refs.; 4 figs.

7721 (KFKI–1993-11/A, pp. 15-26) **Rehadronisation mechanisms in ultrarelativistic heavy ion collisions.** Zimanyi, J. (Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics); Levai, P.; Lukacs, B.; Racz, A. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

In ultrarelativistic heavy ion collisions a piece of matter with extremely high energy density will be produced. According to present QCD pictures a kind of quark matter will be created. To understand the processes going on in such collisions, the production and the rehadronisation of the quark matter was discussed separately. Different rehadronisation mechanisms are compared. Specifically, the particle composition of the rehadronised quark matter is investigated, the way as the initial flavor composition of the quark matter is reflected in the hadronic yield. (K.A.) 16 refs.; 11 figs.; 1 tab.

7722 (KFKI–1993-11/A, pp. 27-30) **The hadronization of a quark-gluon plasma.** Knoll, J. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany)). Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

The hadronization process of an expanding quark-gluon plasma is studied within two different non-equilibrium approaches. In the flavor kinetic model, a bulk transition mechanism is considered including resonance decay and particle evaporation, while in the second model the decay is explored through the evaporation of hadrons from the surface of a plasma droplet. The yield of different hadrons are calculated. In particular the production of strange hadrons and of vector mesons are discussed in the light of recent data from ultra-relativistic nucleus-nucleus collisions. (author) 21 refs.; 6 figs.

7723 (KFKI–1993-11/A, pp. 31-35) **Measurements from Au+Au interactions at 11.6 A GeV/c.** Tannenbaum, M.J. (Brookhaven National Lab., Upton, NY (United States)). E802 Collaboration. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. Contract DE-AC02-76CH00016. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

In a series of experiments at the AGS, the E802 Collaboration has measured inclusive and semi-inclusive production of identified charged particles and two particle correlations, with global event characterization, using beams of 14.6 A GeV/c protons, ^{16}O, ^{28}Si on targets of Be, Al, Cu, Ag and Au. In April and May 1992, a ^{197}Au beam of momentum 11.56 A GeV/c was commissioned at the BNL-AGS Tandem Complex. Preliminary results of measurements from the first Au+Au run are presented as well as a review of other selected results. (K.A.) 11 refs.; 5 figs.

7724 (KFKI–1993-11/A, pp. 36-46) **Recent results from the NA44 Collaboration.** Loerstad, B. (Lund Univ. (Sweden). Dept. of Particle Physics). NA44 Collaboration. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

NA44 is a second generation experiment, optimized for the study of identified single and two particle distributions at mid-rapidity. The spectrometer is a focussing spectrometer, a design which optimizes the acceptance for pairs of particles with small momentum difference. High statistics allow studies of details of the correlation function. Data on the following subjects are discussed for low p_t enhancement in p+Pb and A+A data, $\pi^+\pi^+$ correlations, KK correlations, multidimensional analysis and the resonance influence on the correlation function as simulated by the Fritiof-Spacer model. (author) 8 refs.; 9 figs.; 3 tabs.

7725 (KFKI–1993-11/A, pp. 47-51) **Edgeworth expansion of Bose-Einstein correlation functions.** Hegyi, S. (Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics); Csoergoe, T. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

A systematic study of the shape of Bose-Einstein correlation functions is presented. The emphasis is made on the characterization of the degree of deviation from the pure Gaussian in terms of the cumulant moments higher than the second. The Edgeworth expansion of the correlation functions is shown to be well suited to measure how the non-Gaussian terms influence the extracted fitting parameters. As an illustrative example, the AFS and NA44 data for $C_2(Q_{inv})$ are analysed. It was found that the third and fourth cumulants have nonvanishing contribution to the shape of the correlation functions. (author) 9 refs.; 1 fig.; 3 tabs.

7726 (KFKI–1993-11/A, pp. 52-58) **Global characteristics of relativistic heavy-ion collisions at SPS, RHIC and LHC energies in string fusion model.** Bravina, L.V. (Bergen Univ. (Norway). Dept. of Pharmacology); Amelin, N.S.; Braun, M.A.; Pajares, C.; Csernai, L.P. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

Global characteristics of hh, hA and AA collisions at SPS, RHIC and LHC energies are examined within the Monte-Carlo String Fusion Model (SFM). The possible influence of the string fusion on the basic features of relativistic heavy-ion collisions is studied. Particularly, in AA interactions at ultra-relativistic energies, string fusion can lead to a reduction of multiple production with relative enhancement of the baryon component. (author) 25 refs.; 4 figs.

7727 (KFKI–1993-11/A, pp. 59-64) **Covariant transport theory for quark systems.** Vetter, T. (Justus-Liebig Univ., Giessen (Germany). Inst. fuer Theoretische Physik); Kalmbach, U.; Biro, T.S.; Mosel, U. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

Stationary soliton solutions of the coupled Vlasov and nonlinear Poisson equations were studied in order to describe the initial state of hadronic collisions within the framework of a one-dimensional semiclassical quark transport theory. General conditions were obtained for the existence of solitons analytically and present a simple scheme for its construction. The Vlasov equation was solved for a soliton initialized in such manner by the test-particle method, and the stability of the soliton, was verified. (author) 12 refs.; 3 figs.; 1 tab.

7728 (KFKI–1993-11/A, pp. 83-90) **Breakup of halo nuclei.** Vaagen, J.S. (Bergen Univ. (Norway). Dept. of Physics); Bang, J.M.; Thompson, I.J.; Zhukov, M.V.; Fedorov, D.V.; Danilin, B.V. RNBT Collaboration. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

The question of how can one learn about the potentially exotic structure of radioactive beam nuclei and the interplay between nuclear structure and reaction mechanisms is addressed. A satisfactory treatment within a three-body model for the projectile requires a four-body continuum calculation. A phenomenological discussion is given based on the available data for ^6He and ^{11}Li projectiles. The data can be consistently understood in a picture where the high energy data mainly correspond to direct break-up of the projectile ground state in a Serber model, while the low energy data exhibit the fingerprint of a sequential break-up process via a narrow low-lying resonance, observed in ^6He but hitherto not identified in ^{11}Li. (K.A.) 45 refs.; 4 figs.

7729 (KFKI–1993-11/A, pp. 91-97) **The path of hot nuclei towards multifragmentation.** Papp, G. (Roland Eoetvoes Univ., Budapest (Hungary). Inst. for Theoretical Physics); Noerenberg, W. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245–: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

The projectile-like particle evolution of the Au+X high energy collision is studied in an extended evaporation model. The residue is calculated in the modified abrasion model, and its dynamical evolution into the instability region of nuclear matter is investigated. The calculated nuclei may be an input for statistical multifragmentation models. (author) 13 refs.; 5 figs.

7730 (KFKI–1993-11/A, pp. 98-106) **Intermittent pattern of dynamical fluctuations in relativistic heavy ion collisions.** Bao-An Li (Hahn-Meitner-Inst., Berlin (Germany). Bereich Kern- und Strahlenphysik). Hungarian Academy of Sciences, Budapest

(Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245--: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

By performing hadronic transport model calculations for relativistic heavy ion collisions, properties of dynamical fluctuations from event to event are studied by calculating the reduced scaled factorial moments as a function of the bin size in pseudorapidity. The reduced scaled factorial moments of charged pions were found to show an intermittent behaviour due to the random cascading property of the reaction. Effects of mixing events of different impact parameters on the reduced scaled factorial moments have also been studied. Discrepancies between the model calculations and the experimental data are discussed. (author) 35 refs.; 4 figs.

7731 (KFKI-1993-11/A, pp. 113-119) **Pion dynamics and lepton pair production in heavy ion collisions.** Koch, P. (Regensburg Univ. (Germany). Inst. fuer Theoretische Physik). Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245--: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

The production of lepton pairs with low invariant mass as probes for the pion dynamics in relativistic nuclear collisions is discussed in some detail. The implications of a possible large positive pion chemical potential for the production rate of lepton pairs are emphasized. A strong enhancement has been found in the low invariant mass region, $2m_{\pi} \leq M_{\mu+\mu-} \leq 600$ MeV, for lepton pairs which are produced via the annihilation of pions in the hot and dense collision zone. Calculations for dilepton mass spectra are presented based on different nuclear collision scenarios. It is found that the di-muon mass spectrum can serve as a useful probe to distinguish between these different scenarios. (author) 27 refs; 5 figs.

7732 (KFKI-1993-11/A, pp. 120-129) **Eta and dilepton production in heavy-ion reactions.** Wolf, Gy. (Giessen Univ. (Germany). Inst. fuer Theoretische Physik); Cassing, W.; Mosel, U. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245--: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

A nonperturbative dynamical study of η-meson and pion production in heavy-ion collisions from 1 to 2 GeV/A bombarding energy is presented. The dynamical evolution of the nucleus-nucleus collision is described by a transport equation of the Boltzmann-Uehling-Uhlenbeck type evolving phase-space distribution functions. Furthermore, results are presented for differential dilepton yields in heavy-ion collisions. The sensitivity of the calculated yields to predicted changes of the ρ meson in dense matter is investigated and the feasibility to measure the time-like electromagnetic form factor of hadrons and their medium-dependence through the observation of dileptons is discussed. (author) 40 refs.; 11 figs.

7733 (KFKI-1993-11/A, pp. 130-134) **Kinetics of partons and pions in ultrarelativistic heavy ion collisions probed by dileptons.** Kaempfer, B. (Research Center Rossendorf, Dresden (Germany). Inst. for Nuclear and Hadron Physics); Pavlenko, O.P. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245--: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

Basing on a transport model of Boltzmann type the evolution of relevant degrees of freedom are studied in the course of ultrarelativistic heavy ion collisions. First the approach of dense parton matter is considered towards quark gluon plasma. The pre-equilibrium parton matter is found to represent an important source of continuum dileptons in the J/ψ region at very high beam energies (RHIC and LHC). Second dense off-equilibrium pion matter is analyzed. An approximately constant effective pion chemical potential has been found. Such a scenario results in a strongly increased dilepton yield from hadron matter near the kinematical threshold for producing muon pairs via pion annihilation. (author) 16 refs.; 5 figs.

7734 (KFKI-1993-11/A, pp. 135-137) **Collisions in an expanding pion gas and the $p_{perpendicular}$ spectrum in ultrarelativistic heavy ion collisions.** Barz, H.W. (Fachinformationszentrum Rossendorf (Germany). Inst. fuer Kern-und Hadronenphysik); Bertsch, G.; Danielewicz, P.; Schulz, H.; Welke, G.M. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245--: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

Neglecting the mean field effects, the bosonic Boltzmann equation was solved for an expanding gas of pions using the in-medium scattering matrix from a Bethe-Goldstone type equation. The increase of the scattering rate in the gas for large final state Bose occupancy factors in nearly compensated by an overall drop of the in-medium cross section. Investigating the effect of the $\pi\pi$ scattering in thermalizing the momentum distribution small values of the hadronization time are needed to obtain a strong enhancement at low $p_{perpendicular}$. (author) 11 refs.; 2 figs.

7735 (KFKI-1993-11/A, pp. 138-141) **Kalman filter as the third person of the Landsbergian scheme in heavy ions reactions.** Lukacs, B. (Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics); Racz, A. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Apr 1993. (CONF-9208245--: Budapest workshop on relativistic heavy ion collisions, Budapest (Hungary), 10-13 Aug 1992). In *Proceedings of the Budapest workshop on relativistic heavy ion collisions.* 149p. Order Number DE94611162. Source: OSTI; NTIS (US Sales Only); INIS.

Energetic heavy ion collisions are generally not equilibrium processes in thermodynamic sense. Therefore, even the number of thermodynamic degrees of freedom is not a priori known. It is shown that a combination of Landsberg's scheme for finding the independent macroscopic variables and the Kalman filtering of systems analysis yields an operative tool for determining the degrees of freedom. The procedure is demonstrated on a simple example, which, however is a reaction definitely off local equilibrium. (author) 8 refs.; 1 fig.

7736 (LA--12651-T) **Elastic scattering of pions from tritium and ^{3}He in the backward hemisphere in the region of the Δ_{33}(1232) resonance.** Matthews, S.K. Los Alamos National Lab., NM (United States). Nov 1993. 144p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94003376. Source: OSTI; NTIS; INIS; GPO Dep.

Thesis. Submitted to University of George Washington, Washington, DC.

Several experiments have measured nominally-charge-symmetric scattering of pions from tritium (^{3}H) and ^{3}He. These experiments have covered incident pion energies from 142 MeV to 295 MeV and scattering angles up to 110° in the laboratory. The results have been used to study charge-symmetry breaking and nuclear scattering systematics. In the work I have extended these measurements to angles near 180° for pion energies of 142 MeV, 180 MeV, 220 MeV, and 256 MeV, which bracket the Δ_{33} pion-nucleon resonance. This is the most extensive set of πT and π^3He data in this kinematical region. It will allow tests of scattering theory of pion-nucleus interactions and charge-symmetry breaking in back-angle scattering, and, within the limits of these two theories, it may help improve our understanding of the structure of these nuclei.

7737 (LA--12691-T) **Pion single charge exchange in three body nuclei at intermediate energies.** Dowell, M.L. Los Alamos National Lab., NM (United States). Jan 1994. 244p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005617. Source: OSTI; NTIS; INIS; GPO Dep.

Thesis submitted to Massachusetts Institute of Technology, Cambridge, MA.

The purpose of this thesis is to present new experimental information about modifications to the pion-nucleon single charge exchange interaction, $\pi^+ n \rightarrow \pi^0 p$ or $\pi^- p \rightarrow \pi^0 n$, due to the presence of other nucleons. The results of two experimental studies of pion single charge exchange in the three nucleon system near the Δ-resonance are presented. Both of these experiments were performed at the Clinton P. Anderson Meson Physics Facility (LAMPF), a division of the Los Alamos National Laboratory. Each explored different aspects of pion single charge exchange in three body nuclei–^{3}He and ^{3}H. Since the nuclear wavefunctions of the three nucleon systems are believed to be well understood, it should be possible to perform theoretical calculations of pion interactions with this system and compare their predictions with the experimental results.

7738 (LBL–34724) **Multifragmentation: Surface and Coulomb instabilities of sheets, bubbles, and donuts.** Moretto, L.G.; Tso, Kin; Wozniak, G.J. Lawrence Berkeley Lab., CA (United States). Aug 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9309278–1: International workshop on dynamical features of nuclei and finite fermi systems, Barcelona (Spain), 13-17 Sep 1993). Order Number DE94003242. Source: OSTI; NTIS; INIS; GPO Dep.

Disks, bubbles, and donuts have been observed in dynamical calculations of heavy ion collisions. These shapes are subject to a variety of surface and Coulomb instabilities. These instabilities are identified and analyzed in terms of their relevance to multifragmentation.

7739 (UCRL-JC–112926) **Backward emission of protons in Au+Au collisions at 11.7 A.GeV/c.** Ahle, L. (Massachusetts Inst. of Tech., Cambridge, MA (United States)); Akiba, Y.; Beavis, D. Lawrence Livermore National Lab., CA (United States). Aug 1993. 4p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC02-76CH00016 ; W-31109-ENG-38. (CONF-930636–11: 10. international conference on ultra-relativistic nucleus-nucleus collisions, Borlaenge (Sweden), 20-24 Jun 1993). Order Number DE94003637. Source: OSTI; NTIS; INIS; GPO Dep.

We present preliminary results for the emission of target rapidity protons in minimum bias and central 11.7 A.GeV/c Au+Au collisions. The data span the pseudo-rapidity range $|\eta| \leq 0.76$ and proton kinetic energy range of $50 \leq E \leq 200$ MeV. The slopes of the kinetic energy spectra and $dN/d\eta$ values for central and minimum bias collisions are strikingly similar. Comparison of the results to results for Si+Au and p+A shows that the shape of the $dN/d\eta$ distribution is independent of the reaction system or centrality suggesting that the spectator matter does not play a decisive role in determining the shape of the proton distributions at back angles for these systems at AGS energies.

6635 Nuclear Mass Ranges

Refer also to citation(s) 7555, 7666, 7673, 7676, 7677, 7684, 7686, 7688, 7689, 7691, 7695, 7698, 7699, 7700, 7701, 7702, 7703, 7704, 7706, 7710, 7713, 7714, 7736, 7737

6636 Radiation Physics

Refer also to citation(s) 6309, 6322, 6647, 7262, 7343, 7760, 7775, 7851, 7952

7740 (PNL-SA–22412) **SYNTH: A spectrum synthesizer.** Hensley, W.K.; McKinnon, A.D.; Miley, H.S.; Panisko, M.E.; Savard, R.M. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-931107–26: 1993 IEEE nuclear science symposium and medical imaging conference, San Francisco, CA (United States), 2-5 Nov 1993). Order Number DE94004719. Source: OSTI; NTIS; INIS; GPO Dep.

A computer code has been written at the Pacific Northwest Laboratory (PNL) to synthesize the results of typical gamma ray spectroscopy experiments. The code, dubbed SYNTH, allows a user to specify physical characteristics of a gamma ray source, the quantity of the nuclides producing the radiation, the source-to-detector distance and the presence of absorbers, the type and size of the detector, and the electronic set up used to gather the data. In the process of specifying the parameters needed to synthesize a spectrum, several interesting intermediate results are produced, including a photopeak transmission function versus energy, a detector efficiency curve, and a weighted list of gamma and x rays produced from a set of nuclides. All of these intermediate results are available for graphical inspection and for printing. SYNTH runs on personal computers. It is menu driven and can be customized to user specifications. SYNTH contains robust support for coaxial germanium detectors and some support for sodium iodide detectors. SYNTH is not a finished product. A number of additional developments are planned. However, the existing code has been compared carefully to spectra obtained from National Institute for Standards and Technology (NIST) certified standards with very favorable results. Examples of the use of SYNTH and several spectral results are presented.

7741 (PNL-SA–22813) **Neutron interactions and atomic recoil spectra.** Greenwood, L.R. Pacific Northwest Lab., Richland, WA (United States). Aug 1993. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9308204–1: International summer school on fundamentals of radiation damage, Urbana, IL (United States), 1-12 Aug 1993). Order Number DE94004774. Source: OSTI; NTIS; INIS; GPO Dep.

This chapters presents a discussion of neutron interactions with materials that lead to activation, transmutation, and atomic displacements. The emphasis will be on current applications including neutron irradiation facilities, neutron dosimetry techniques, and computer codes for spectral adjustment and radiation damage calculations.

7742 (PSI-PROC–93-01, pp. 313-329) **Quantum neutron optics.** Rauch, H. (Atominstitut der Oesterreichischen Universitaeten, Vienna (Austria)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

The invention of neutron interferometry in 1974 stimulated many experiments related to the wave-particle dualism of quantum mechanics. Widely separated coherent beams can be produced within a perfect crystal interferometer which can be influenced by nuclear, magnetic and gravitational interaction. The verification of the 4π-symmetry of spinor wave functions and of the spin superposition law at a macroscopic scale and the observation of gravitational effects including the Sagnac effect have been widely debated in literature. The coupling of the neutron magnetic moment to resonator coils permitted the coherent energy exchange between the neutron quantum system and the macroscopic resonator. This phenomenon provided the basis for the observation of the magnetic Josephson effect with an energy sensitivity of 10^{-19} eV. Partial beam path detection experiments are in close connection with the development of quantum mechanical measurement theory. The very high sensitivity of neutron interferometry may be used in future for new fundamental-, solid-state and nuclear-physics application. A striking spectral modulation effect has been observed by means of a proper post-selection procedure under conditions where the spatial shift of the wave trains greatly exceeds the coherence length of the neutron beams traversing an interferometer. It is shown that Schroedinger-cat-like states are created by the superposition of two coherent states generated in the interferometer. These entangled states exhibit under certain circumstances characteristic squeezing phenomena indicating a highly non-classical behavior. Analogies with light optical experiments are discussed. (author) 10 figs., 66 refs.

7743 (PSI-PROC–93-01, pp. 331-357) **Neutron sources.** Bauer, G.S. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

There is an almost unlimited range of science in which neutron scattering plays an essential role in solving difficult and important problems. Unfortunately, suitable neutrons are not readily available.

Although about half of our world is made up of neutrons, they are tightly bound deep inside the atomic nucleus and quite difficult to set free. Facilities that accomplish this task in a manner useful for scientific and technological application are commonly called neutron sources. In the present context we are ultimately interested in providing "epithermal", "hot", "thermal" and "cold" neutrons. Obviously these temperatures ranges do not really characterize thermal properties of the neutrons themselves, but rather the temperature of the substance those neutrons were in thermal equilibrium with before leaking out through its surface. The exception are "epithermal" neutrons, which leak out during the slowing-down process before reaching thermal equilibrium. In this paper we will deal with ways to set free neutrons from the nuclei in the first place and to slow them down to useful energies afterwards. Actual designs of some types of "neutron sources" will be described in the light of their suitability for neutron scattering experiments and their prospects for further progress. (author) 18 figs., 19 refs.

6640 Atomic and Molecular Physics

Refer also to citation(s) 7586

6641 Theory of Electronic Structure of Atoms and Molecules

Refer also to citation(s) 7843

7744 (LBL–34728) **Magnetic, optical and charge-transfer spectra of antiferromagnetic solid α-O_2 and "paramagnetic" solid β-O_2: A small-cluster, many-electron calculation.** da Silva, A.J.R. (California Univ., Berkeley, CA (United States). Dept. of Physics); Falicov, L.M. California Univ., Berkeley, CA (United States). Dept. of Physics. Oct 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9308175–2: Latin American workshop on magnetism, Guanujuato (Mexico), 23-28 Aug 1993). Order Number DE94003248. Source: OSTI; NTIS; GPO Dep.

The electronic spectra of α and β solid O_2 were calculated in a full many-body approach for a cluster consisting of four O_2 molecules with periodic boundary conditions. By including only the partially occupied π orbitals (16 spin-orbitals, 8 electrons) the basis set consists of 12870 many-electron states. Use of the symmetry properties (group-theoretical analysis) simplifies the problem considerably. Resulting spectra – with phenomenological Hamiltonian parameters obtained from experiment – consist of separate regions: (a) 81 states corresponding to the ground state and low-energy magnetic excitations (magnons); (b) 1215 states of neutral molecular excitations (excitons); and (c) 11574 charge-transfer states (conducting high-energy states). Analysis of the properties of the ground states in both α and β solid O_2 has been carried out.

6642 Spectra of Atoms and Molecules and Their Interactions With Photons

Refer also to citation(s) 7503

6643 Collision Phenomena

Refer also to citation(s) 7835

7745 (ANL/ER/PP–77881) **Double excitation of He and H^- by fast proton and anti-proton impact.** Hino, Ken-ichi (University of Electro-Communications, Chofu, Tokyo (Japan)); Moribayashi, K.; Nagase, M.; Matsuzawa, M.; Kimura, M. Argonne National Lab., IL (United States). [1993]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94004581. Source: OSTI; NTIS; INIS; GPO Dep.

Theoretical investigation has been made on double excitation processes of He and H^- by fast proton and anti-proton impact in the MeV/u-energy region. The cross sections are calculated by use of both the close-coupling and the perturbation expansion methods, and the wave functions of target atoms are generated based on the hyperspherical coordinate method. The excitation to the $2p^2\ ^1D^e$ state of H^- by anti-proton impact is dominant by about three times in comparison with that by proton impact at the incident energy of 0.1 MeV/u. The spectral shape of an ejected electron from the $2s2p\ ^1p^o$ state of H^- at the incident energy of 1.5 MeV/u is consistent with the line profile of the H^- photodetachment observed by Bryant et al.

7746 (DOE/ER/13844–T1) **[Reactive collisions of high-temperature systems]: [Technical progress report 1990].** Graff, M.M. Georgia Inst. of Tech., Atlanta, GA (United States). [1990]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-88ER13844. Order Number DE94003948. Source: OST!; NTIS; INIS; GPO Dep.

The object of this research is to study reactivity at superthermal collision energies using a fast neutral beam that is generated by photodetachment. Systems scheduled for initial study include basic oxygen-hydrogen reactions. Unfortunately, we can not yet report realization of this goal, but during this funding period we have made advances that are anticipated to lead to successful measurements during the next year. The parameters described below refer to the model system $O + H_2 \rightarrow OH + H$. The basic design involves the collision of fast neutrals, created by photodetachment of the corresponding negative molecular ion, with a stable reactant gas in a collision cell. Products are detected by ionization and mass analysis. We are equipped to study rotational effects on reactivity by comparing results for rotational levels J = 0 and 1 of H_2. Highlights during the funding period are given in this report.

7747 (DOE/ER/13849–6) **Low energy ion-molecule reactions and chemilonization kinetics: Progress report, February 1, 1991–January 31, 1994.** Farrar, J.M. Rochester Univ., NY (United States). 26 Jul 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER13849. Order Number DE94005414. Source: OSTI; NTIS; GPO Dep.

Work over the past 3 years was directed toward the dynamics of elementary gas phase proton transfer reactions, particularly those of the O^- ion. Such reactions are important in flames. Published work over the past 30 months was concerned with dynamics of reactions of O^- with H_2O, NH_3, and HF. Results are enumerated here.

7748 (LA–12604-MS) **Relativistic collision rate calculations for electron-air interactions.** Graham, G. (EG and G Energy Measurements, Inc., Los Alamos, NM (United States)); Roussel-Dupre, R. Los Alamos National Lab., NM (United States). Dec 1993. 51p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36 ; AC08-93NV11265. Order Number DE94004204. Source: OSTI; NTIS; GPO Dep.

The most recent data available on differential cross sections for electron-air interactions are used to calculate the avalanche, momentum transfer, and energy loss rates that enter into the fluid equations. Data for the important elastic, inelastic, and ionizing processes are generally available out to electron energies of 1–10 keV. Prescriptions for extending these cross sections to the relativistic regime are presented. The angular dependence of the cross sections is included where data are available as is the doubly differential cross section for ionizing collisions. The collision rates are computed by taking moments of the Boltzmann collision integrals with the assumption that the electron momentum distribution function is given by the Juettner distribution function which satisfies the relativistic H- theorem and which reduces to the familiar Maxwellian velocity distribution in the nonrelativistic regime. The distribution function is parameterized in terms of the electron density, mean momentum, and thermal energy and the rates are therefore computed on a two dimensional grid as a function of mean kinetic energy and thermal energy.

6644 Experimentally Derived Information On Atomic and Molecular Properties

Refer also to citation(s) 7745

6650 Physics of Condensed Matter

Refer also to citation(s) 7030, 7134

7749 (BNL–49777) **Low frequency dynamics of CO/Cu-breakdown of Born-Oppenheimer approximation.** Hirschmugl, C. (Yale Univ., New Haven, CT (United States)); Williams, G.P.; Chabal, Y.J.; Hoffmann, F.M. Brookhaven National Lab., Upton, NY (United States). [1993]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9311104–16: 40. national symposium of the American Vacuum Society (AVS), Orlando, FL (United States), 15-19 Nov 1993). Order Number DE94005508. Source: OSTI; NTIS; GPO Dep.

Synchrotron infrared studies of adsorbates on surfaces offer the possibility of probing low frequency vibrational modes and dynamics at high resolution (1 cm^{-1}, 125 μeV). Extensive experiments have been performed for ordered submonolayers of CO on low index Cu surfaces [($\sqrt{3}$ x $\sqrt{3}$)R30° CO/Cu(1ll), c(2 x 2) CO/Cu(100) and (1 x 2) CO/Cu(l10)], in the 100-2500 cm^{-1} (~12.5 – 312.5 MeV) range. These are the first IR experiments to directly probe the adsorbate-substrate vibrations for this system. In addition, however, several surprising features are observed including the dipole-forbidden hindered rotation and an unexpected broad-band absorption. Two theories have been motivated by this work, and will be compared to our experimental results. The first theory is a cluster calculation by Head-Gordon and Tully, which takes into account the breakdown of the Born-Oppenheimer approximation and predicts lifetimes and frequencies of the vibrational modes for CO/Cu(100). Another Drude-based theory, proposed by Persson, considers the coupling of the conduction electron current to the vibrations of the adsorbates, accounting for the observation of both the broad-band absorption and dipole-forbidden peak.

7750 (BNL–49782) **Surface modes and chiral symmetry (Wilson fermions in a box).** Creutz, M.; Horvath, I. Brookhaven National Lab., Upton, NY (United States). Dec 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9310250–2: LATTICE 93: international symposium on lattice field theory, Dallas, TX (United States), 12-17 Oct 1993). Order Number DE94004946. Source: OSTI; NTIS; INIS; GPO Dep.

We give a Hamiltonian discussion of surface states in an extra dimension as a basis for chiral fermions in lattice models. Such modes appear with the Wilson fermion action when the hopping parameter exceeds a critical value. The association of such states with the closing and reopening of a band gap was noted by Shockley in 1939.

7751 (DOE/FTR–94002462) **Travel to Greece and Germany for meetings on the electronic structure of solids and complex systems: Foreign trip report, September 16–October 1, 1993.** Daw, M.S. Sandia National Labs., Livermore, CA (United States). 6 Oct 1993. 45p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94002462. Source: OSTI; NTIS (US Sales Only); GPO Dep.

European Research Conferences are held all over Europe. The conferences are intended to provide an open forum for discussions of the latest developments in the field of interested by participants from all nations. At this particular conference in Greece, the European leaders (and some also from the US) met to discuss the state of the art of computing electronic structure of solids, with special emphasis on properties of surfaces, interfaces, and localized defects. In Germany, the conference focused more specifically on the use of approximate electronic structure methods for large or complex systems, where more rigorous methods are too expensive. At both conferences, the author presented recent advancements in the calculations of electronic properties of large systems, based on the new density-matrix method.

6651 Nuclear Techniques In Condensed Matter Physics

Refer also to citation(s) 7081, 7147, 7203, 7538

7752 (DOE/ER/60437–8) **Electron microscope studies: Progress report, June 1, 1992–November 1, 1993.** Crewe, A.V.; Kapp, O.H. Chicago Univ., IL (United States). Enrico Fermi Inst. 1 Nov 1993. 53p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER60437. Order Number DE94003068. Source: OSTI; NTIS; INIS; GPO Dep.

During the past year we have continued our work on the mirror-corrected high resolution STEM. We have made significant progress in the design and fabrication of the various microscope sub-systems and have completed a new display system. Additional calculations and computer simulations have been performed to confirm the original theory of mirror correctors. In our biological work we have made a careful study of the structure of globins, vertebrate and invertebrate, using the accumulated information contained in the Brookhaven Data Bank (3D structures), the Protein Identification Resource (ID sequences) and the data we have obtained with the STEM. Statistical templates have been generated to predict various classes of globins.

7753 (DOE/FTR–94000999) **Travel to Scotland and Switzerland to participate in the 5th International Conference on Hopping and Related Phenomena: Foreign trip report, August 29, 1993–September 11, 1993.** Emin, D. Sandia National Labs., Albuquerque, NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE94000999. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Hopping conduction is a subject area that encompasses incoherent transport of electrons, atoms or energy. The biannual hopping conference focuses on fundamental studies of these phenomena. The primary topic discussed at this meeting was hopping of electrons between very low densities, 10^{16} cm^{-3}, of large-radius (about 100 Å) dopants in semiconductors. These phenomena are studied at very low temperatures, often < 1 K. However, important hopping phenomena also occur between high densities, < 10^{21} cm^{-3}, of well-localized states, radii < 5 Å, often up to the melting point of solids. Higher-temperature hopping phenomena are commonly found in amorphous semiconductors, polymers, ceramics and biological materials. It is becoming increasingly clear that these two classes of hopping phenomena differ from one another in fundamental ways. At Ecole Polytechnique Federale de Lausanne (EPFL) electronic hopping in conducting polymers was discussed in considerable detail. In addition, plans were made to collaborate in studying the distinctive bonding of boron-rich solids by exposing these materials to intense high-energy bombardment with electrons. Plans to measure electronic transport properties of boron carbides were also developed. Finally, an extension of a present collaboration with M.-N. Bussac (Ecole Polytechnique, France) was planned in which the effects of disorder on the temporal relaxation of carriers injected into insulators is to be investigated.

7754 (DOE/OR/00033–T564) **Resonant holographic measurements of laser ablation plume expansion in vacuum and argon gas backgrounds.** Lindley, R.A. (Michigan Univ., Ann Arbor, MI (United States)). Oak Ridge Inst. for Science and Education, TN (United States); Michigan Univ., Ann Arbor, MI (United States). 1993. 189p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE94001407. Source: OSTI; NTIS; INIS; GPO Dep.

This thesis discusses the following on resonant holographic measurements of laser ablation plume expansion: Introduction to laser ablation; applications of laser ablation; The study of plume expansion; holographic interferometry; resonant holographic interferometry; accounting for finite laser bandwidth; The solution for doppler broadening and finite bandwidth; the main optical table; the lumonics laser spot shape; developing and reconstructing the holograms; plume expansion in RF/Plasma Environments; Determining λ_o; resonant refraction effects; fringe shift interpretation; shot-to-shot consistency; laser ablation in vacuum and low pressure, inert, background gas; theoretically modeling plume expansion in vacuum and low pressure, inert, background gas; and laser ablation in higher pressure, inert, background gas.

7755 (IS-T–1664) **RHEED studies of the nucleation, growth, and mobility of Ag atoms on the Si(111)7 x 7 surface.** Roos, K.R. Ames Lab., IA (United States). Jul 1993. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005551. Source: OSTI; NTIS; INIS; GPO Dep.

The low temperature and flux dependent growth of ultrathin Ag films on the Si(111)7x7 surface is studied with Reflection High-Energy Electron Diffraction (RHEED). The grazing incidence geometry of RHEED allows for an incident molecular beam normal to the surface, and makes it an ideal surface probe for studying ultrathin film growth in real time. Short-lived oscillations in the diffracted intensity are observed during Ag deposition at 150 K, indicating quasi-layer-by-layer growth mediated by adatom mobility. When the 150 K growth is performed over a wide range of deposition rates F, the peak intensity is observed to scale, i.e. I(Ft) depends only on the total amount deposited, which implies thermally activated diffusion is absent at 150 K. Scaling is not obeyed at higher temperatures ($T \geq 473$ K) for the growth of the $\sqrt{3} \times \sqrt{3}$ R30° ($\sqrt{3}$) superstructure. Testing for scaling of the diffracted intensity constitutes a new experimental method which can be applied generally to determine if thermal diffusion is active at a particular temperature. Scaling is consistent with a constant diffusion length R_0, independent of substrate temperature and deposition rate. The presence of a non-thermal diffusion mechanism (responsible for the constant diffusion length R_0) is confirmed by monitoring the flux dependence of the $\sqrt{3}$ superstructure growth during deposition at $T \geq 473$ K. At these temperatures the total diffusion length R is given by $R=R_0+(4Dt)^{1/2}$, where $(4Dt)^{1/2}$ is the thermal component. A non-zero intercept R_0 is found by plotting the peak intensity $I_p^{1/2}$ (a measure of the average domain size) vs. deposition rate $F^{-1/2}$ (F^{-1} is proportional to the available diffusion time.) From the FWHM of a low coverage (0.2 ML) $\sqrt{3}$ spot, an estimation of 50 Å is made for a lower bound of the magnitude of R_0.

7756 (LBL–31791) **Scalar operators in solid-state NMR.** Sun, Boqin. Lawrence Berkeley Lab., CA (United States). Nov 1991. 260p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94005211. Source: OSTI; NTIS; GPO Dep.

Selectivity and resolution of solid-state NMR spectra are determined by dispersion of local magnetic fields originating from relaxation effects and orientation-dependent resonant frequencies of spin nuclei. Theoretically, the orientation-dependent resonant frequencies can be represented by a set of irreducible tensors. Among these tensors, only zero rank tensors (scalar operators) are capable of providing high resolution NMR spectra. This thesis presents a series of new developments in high resolution solid-state NMR concerning the reconstruction of various scalar operators motion in solid C_{60} is analyzed.

7757 (PIYaF–1800) **Neutron scattering and antiferromagnetic fluctuations in high-T_c superconductors below T_c.** Maleev, S.V. AN SSSR, Leningrad (Russian Federation). Inst. Yadernoj Fiziki. Jun 1992. 23p. Order Number DE94611521. Source: OSTI; NTIS (US Sales Only); INIS.

The magnetic neutron scattering in the high-T_c superconductors at $T << T_c$ is considered theoretically on the base of the nesting theory. It is shown that only three variants of the gap functions discussed in the literature are compatible with the neutron scattering data: the d-wave gap, the p-wave gap and the mixture of the d-wave gap and the extended s-wave gap functions with the real coefficients. In all these cases the threshold energy for inelastic neutron scattering at the 2D antiferromagnetic Bragg point Q_vector_0 is equal to $2—\mu—$ where μ is the chemical potential. Below this energy the scattering at Q-vector=Q-$vector_0$ is forbidden. However the scattering at Q-vector≃Q-$vector_0$ has to take place and as a result the Q-vector-dependence of the scattering is 'incommensurate' at $\omega \leq 2—\mu—$. In the case of d-wave gap function calculated $Im\chi$(Q-vector, ω) with the reasonable choice of the parameters is in a qualitative agreement with the experimental results. 32 refs.; 3 figs.; 2 tabs.

7758 (PIYaF–1804) **Distribution of captured flux at the Josephson medium.** Aksel'rod, L.A.; Gordeev, G.P.; Zabenkin, V.N.; Kolkhidashvili, M.R.; Lazebnik, I.M.; Ploshchanskaya, E.L.; Sbitnev, V.I. AN SSSR, Leningrad (Russian Federation). Inst. Yadernoj Fiziki. Jun 1992. 24p. (In Russian). Order Number DE94611522. Source: OSTI; NTIS (US Sales Only); INIS.

The patterns of a distribution of inner fields in the ceramic sample Y-Ba-Cu-O are obtained by means of the neutron polarized beam scanning. The information about the Josephson screening currents is extracted from these patterns for the fields smaller than a low critical field of grains. Dependencies of the screening currents versus the inner field B near the sample boundary and in its depth are distinguished with one another. Maximum accessible values of screening current densities are corresponded to a critical current whose linear fashion depends on the field B. From this dependence an initial critical current density J_0 and a characteristic spatial scale are extracted. 14 refs.; 11 figs.

7759 (PIYaF–1814) **Electronic structure of Pr doped into superconducting Bi-Pb-Sr-Ca-Cu-O ceramics.** Egorov, A.I.; Karazhanova, G.I.; Smirnov, Yu.P.; Sovestnov, A.E.; Tyunis, A.V.; Shaburov, V.A. AN SSSR, Leningrad (Russian Federation). Inst. Yadernoj Fiziki. Jul 1992. 17p. (In Russian). Order Number DE94611523. Source: OSTI; NTIS (US Sales Only); INIS.

The shift of K_{α_1} and K_{β_1} X-ray lines of Pr in HTS-ceramic $Bi_{1.7}Pb_{0.3}Sr_{2-x}Pr_xCa_2Cu_3O_y$ ($0,10 \leq x \leq 0,50$, refer to PrF_3) are measured experimentally. The valence m(x), the charge q(x) and the 4f(x)-, 5d(x)-levels population of Pr are determined from experimental shifts. It is found that the Pr valence is near 3; the small valence increasing $m \simeq 3,04$ at x=0,1 is observed. The small of Pr 5d-electron localization in ceramics in comparison with PrF_3 is revealed (≈0,1-0,2 5d-electron per Pr-atom). The probable cause of the superconductivity suppression in $Y_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$ system is discussed. 26 refs.; 6 figs.; 1 tab.

7760 (PSI-PROC–93-01) **Neutron scattering: Lecture notes of the first summer school on neutron scattering.** Furrer, A. (ed.). No corporate text available. 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). Order Number DE94611406. Source: OSTI; NTIS (US Sales Only); INIS.

This report contains the text of 16 lectures given at the Summer School and the report on a panel discussion entitled "the relative merits and complementarities of x-rays, synchrotron radiation, steady- and pulsed neutron sources". figs., tabs., refs.

7761 (PSI-PROC–93-01, pp. 1-50) **Instruments for neutron scattering.** Bauer, G.S. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Buehrer, W. 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

In this paper we will introduce the principles and concepts necessary to understand what one is doing if one performs an experiment on a certain instrument. We will describe the components of which almost all neutron scattering instruments are made up and their functions and show how these components can be combined to contribute in the best possible way to the solution of questions in a large number of scientific areas. (author) 50 figs., 10 refs.

7762 (PSI-PROC–93-01, pp. 51-71) **Basic concepts for the interpretation of neutron scattering experiments at an atomic level of description.** Lovesey, S.W. (Rutherford Appleton Lab., Chilton (United Kingdom)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

The aim of this note is to provide some information on basic concepts for the interpretation of neutron scattering experiments at an atomic level of description. The presentation is very much at the descriptive level, so there are no examples of the actual working out (algebra) to be done in arriving at results. Readers who wish to see such detail can consult one of the many cited review articles and books. (author) 2 figs., 1 tab., 21 refs.

7763 (PSI-PROC–93-01, pp. 73-95) **Neutron diffraction from polycrystalline materials.** Rodriguez-Carvajal, J. (Laboratoire Leon Brillouin (LLB) - Centre d'Etudes de Saclay , 91 - Gif-sur-Yvette (France)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

In this note we give a short review, at an introductory level, of some topics concerning the study of crystal structures by means of

neutron powder diffraction. A summary of the relevant scattering formulae used for the analysis of powder diffraction data is given. The specific characteristics of neutrons versus X-rays and electrons are emphasized in terms of atomic scattering lengths and absorption cross sections. Some aspects of the resolution of powder diffractometers are discussed in relation with the capacity to refine crystal structures with different degree of complexity and some problems related with crystal structure determination from powder data are discussed. The use of neutron powder diffraction for determining crystal structures of defective materials is illustrated in different cases. Particularly important is the extension of the Rietveld method to investigate the microstructure of solids where the defects cause an anisotropic broadening of the Bragg reflections. (author) 8 figs., 1 tab., 17 refs.

7764 (PSI-PROC–93-01, pp. 97-110) **Neutron diffraction from single crystals.** Heger, G. (Laboratoire Leon Brillouin (LLB) - Centre d'Etudes de Saclay , 91 - Gif-sur-Yvette (France)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

Standard structure analysis on single crystals is a domain of X-ray diffraction (using conventional laboratory equipment) as far as the determination of space group symmetry, cell parameters and the structure model (of non-hydrogen atoms) are concerned. The aim of this lecture is to discuss special cases, for which, in addition to this indispensable part, neutrons are required to solve structural problems. Typical examples of single crystal neutron diffraction studies in the field of small molecular systems are presented here. Powder neutron diffraction applications are treated in a separate lecture and will not be considered. (author) 16 figs., 10 refs.

7765 (PSI-PROC–93-01, pp. 111-127) **Structural excitations.** Dorner, B. (Institut Max von Laue - Paul Langevin (ILL), 38 - Grenoble (France)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

The main emphasis of this paper concerns lattice dynamics. In particular the investigation of phonon dispersion branches and the determination of eigenvectors are discussed. Most of the experiments were performed at the High Flux Reactor of the ILL in Grenoble in close collaboration with many colleagues from outside laboratories. (author) 11 figs., 13 refs.

7766 (PSI-PROC–93-01, pp. 129-156) **Homogeneous linear polymers in solution and binary mixtures.** Schwahn, D. (Forschungszentrum Juelich GmbH (Germany). Inst. fuer Festkoerperforschung). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

In this lecture I discuss equilibrium properties of linear and homogeneous polymers and limit myself to the "global" properties of the polymer. This means that the chemical structure of the repeat unit, the monomer, is irrelevant in this context. The content of the lecture is as follows: classification of polymers in solution, scattering laws of polymers in solution and binary polymer blends for small scattering vectors with respect to the inverse size of the polymer, conformation of polymers in solution and melt, and composition fluctuations in mixed binary polymer blends. (author) figs., tabs, 13 refs.

7767 (PSI-PROC–93-01, pp. 157-176) **Neutron scattering in biology.** Timmins, P.A. (Institut Max von Laue - Paul Langevin (ILL), 38 - Grenoble (France)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

The following topics are treated in this lecture: high resolution neutron crystallography of macromolecules, small angle neutron scattering (SANS) from solutions and low resolution crystallography. 15 figs., refs.

7768 (PSI-PROC–93-01, pp. 177-188) **Neutron scattering from solutions.** Helm, L. (Lausanne Univ., Inst. de chimie minerale et analytique, Lausanne (Switzerland)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

A general description of neutron scattering on liquids is given. The main topic of this report is on the method of differences and its applications to aqueous and non-aqueous solutions of electrolytes. It is shown that the method yields precise structural information about the first coordination sphere of ions. Recent results on aqueous solution of lanthanide(III) ions as well as non-aqueous solution of Ni^{2+} are reported. (author) 8 figs., 11 refs.

7769 (PSI-PROC–93-01, pp. 189-197) **Polarized neutrons.** Boeni, P. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

Experiments which determine the polarization of the incident and the scattered neutrons provide more information about the scattering system than unpolarized beam experiments. By measuring the spin dependent cross sections it is possible not only to distinguish between nuclear and magnetic scattering contributions, it is also possible to discriminate between coherent and incoherent scattering, i.e. between self and collective correlations and between different modes of magnetic excitations. We shall discuss after a short description of the polarization analysis technique some typical examples of recent measurements on magnetic systems like $YBa_2Cu_3O_7$ and EuS. (author) 11 figs., 31 refs.

7770 (PSI-PROC–93-01, pp. 199-234) **Magnetic structures.** Fischer, P. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

As an introduction to the important application of neutron scattering techniques to the investigation of magnetic ordering phenomena in condensed matter relevant theoretical aspects will be sketched and illustrative experimental results will be discussed. (author) 24 figs., tabs., 50 refs.

7771 (PSI-PROC–93-01, pp. 235-252) **Magnetic excitations.** Lander, G.H. (Commission of the European Communities, Karlsruhe (Germany). European Inst. for Transuranium Elements). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

After a brief discussion of the magnetic cross, I present some of the well-known examples of magnetic excitations, such as in Ni, and Gd. In the limit of small exchange interactions and localized-electron states, the excitation spectra consist of crystal-field and spin-orbit levels. An example is given of such excitations in the new high T_c materials containing rare-earths. Finally, I discuss the magnetic excitation spectra in the important case in which an interaction occurs between the valence and conduction-electron states. Such interactions give rise to intermediate valence states, the Kondo, and heavy-fermion ground states, and (possibly) the superconductivity in high T_c materials. (author) 9 figs., 19 refs.

7772 (PSI-PROC–93-01, pp. 253-271) **Magnetic critical phenomena.** Lovesey, S.W. (Rutherford Appleton Lab., Chilton (United Kingdom)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

MAGNETISM/critical temperature; NEUTRONS/scattering; EXCITATION; EXPERIMENTAL DATA; FERROMAGNETIC MATERIALS; FLUCTUATIONS; HYSTERESIS; MAGNETIC SUSCEPTIBILITY; MAGNETISM; MAGNETIZATION; MUON SPIN RELAXATION; NEUTRONS; SCATTERING; ORDER PARAMETERS;

ORDER-DISORDER TRANSFORMATIONS; PARAMAGNETISM; RESPONSE FUNCTIONS

7773 (PSI-PROC–93-01, pp. 273-293) **Wide- and small-angle diffuse scattering from metals and alloys.** Kostorz, G. (Eidgenoessische Technische Hochschule, Inst. fuer Angewandte Physik, Zurich (Switzerland)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

While the coherent elastic scattering of a perfect crystal is restricted to the Bragg peaks characteristic for the (average) structure, real crystals show scattering around and between Bragg peaks. The elastic part of this scattering (elastic diffuse scattering) contains information on the occupation of lattice sites and on local displacements. In an initially homogeneous alloy (quenched solid solution) local ordering or phase separation may occur on the way towards thermodynamic equilibrium. The various diffuse scattering effects, including those around the incident beam, are discussed and illustrated by recent results on short-range order and decomposition in Ni and Cu alloys. (author) 12 figs., 87 refs.

7774 (PSI-PROC–93-01, pp. 295-312) **Neutron and x-ray scattering from amorphous systems.** Lamparter, P. (Max-Planck-Institut fuer Metallforschung, Stuttgart (Germany). Inst. fuer Physik). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

The application of neutron scattering for the investigation of the structure of amorphous materials is illustrated by means of some selected examples. These examples were taken from the group of amorphous metallic alloys, the so-called metallic glasses, however the described experimental and data-reduction procedures apply to amorphous and liquid alloys in general. Comparison with x-ray scattering is made in some cases to illustrate the complementary properties of both probes. Structural aspects of metallic glasses are treated only as far as neutron (and x-ray) diffraction is concerned. A more detailed description of the structure of amorphous and molten alloys may be found in a recent review article. Three-dimensional structural models are briefly described as a possibility to overcome the limitations of diffraction methods which yield one-dimensional information only. Hydrogen in amorphous materials, as a challenge for neutron scattering studies, is a special topic. (author) 12 figs., 24 refs.

7775 (PSI-PROC–93-01, pp. 359-368) **Panel discussion on the relative merits and complementarities of x-rays, synchrotron radiation, steady state- and pulsed neutron sources.** Bauer, G. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). 1993. 384p. (CONF-9308201–: 1. summer school on neutron scattering, Zuoz (Switzerland), 15-21 Aug 1993). In *Neutron scattering: Lecture notes of the first summer school on neutron scattering.* Order Number DE94611406.

The topics of the panel discussion were: structure determination by diffraction methods, excitations, elastic disorder scattering, magnetic structures and excitations, and an outlook.

6653 Interactions Between Beams and Condensed Matter

Refer also to citation(s) 6932, 7033, 7070, 7072, 7074, 7082, 7083, 7116, 7147, 7194, 7203

7776 (BUDKERINP–91-117) **Quantum effects in channeling radiation.** Bajer, V.N.; Katkov, V.M.; Strakhovenko, V.M. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1991. 20p. (IYaF–91-117.). Order Number DE94611538. Source: OSTI; NTIS (US Sales Only); INIS.

The quantum effects in the total intensity of radiation at channeling have been considered. It is shown that the problem can be considered in frame of magnetic bremsstrahlung limit. In a region, where quantum effects are weak, the general formulae have been obtained for quantum corrections to the total intensity of the channeling radiation. While in diamond and silicon the quantum effects become noticeable at energy of order 5 GeV, in tungsten the quantum effects lead to appreciable decreasing the radiation intensity already at energy 1 GeV: order of 25% at room temperature and 34% at T=77 K. 9 refs.; 3 figs.

7777 (CONF-9311153–1) **Density reduction: A mechanism for amorphization at high ion doses.** Specht, E.D. (Oak Ridge National Lab., TN (United States)); Zinkle, S.J.; Walko, D.A. Oak Ridge National Lab., TN (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Materials Research Society meeting; Pittsburgh, PA (United States); 29 Nov - 3 dec 1993. Order Number DE94004793. Source: OSTI; NTIS; GPO Dep.

At cryogenic temperatures, the accumulation of vacancy-interstitial pairs in Al_2O_3 from atomic displacements associated with ion implantation produces amorphization. At room temperature, these pairs recombine, and amorphization occurs only at high doses. X-ray reflectivity measurements show that amorphization of the surface of Al_2O_3 implanted at room temperature with 160 keV Cr^+ ions is preceded by a progressive reduction in near-surface density. Monte Carlo simulations show that this density reduction can be accounted for by high-energy-transfer collisions which knock atoms deep into the target, leaving widely separated vacancies and interstitials, which do not recombine. Electron microscopy shows that at least some of these vacancies condense into voids. We propose that this reduction in near-surface density can lead to amorphization at high doses. We present simple approximations for the density reduction expected for different ions and targets.

7778 (ENEA-RT-INN–92-18, pp. 9-11) **Emission properties of gamma irradiated LIF crystals excited in F absorption band by excimer laser.** Baldacchini, G. (ENEA, Frascati (Italy). Dipt. Sviluppo Tecnologie di Punta); Cremona, M.; Montereali, R.M.; Grassano, U.M.; Kalinov, V. ENEA, Frascati (Italy). Dipt. Sviluppo Tecnologie di Punta. Nov 1992. (CONF-920816–: International conference on defects in insulating materials, Nordkirchen (Germany), 16-22 Aug 1992). In *Contributions to International conference on defects in insulating materials.* 19p. Order Number DE93522969. Source: OSTI; NTIS (US Sales Only).

Among alkali halide crystals, LiF occupies a special place because of its extreme properties. The crystal is almost insoluble in water, the cation-anion distance is the shortest, and the Li+ ion has the smallest radius. Additive coloration does not work, and it is difficult to obtain a sample containing only F centers when irradiated with gamma rays, X-rays, electrons or other high energy particles. The luminescence of the F center, expected around 900 nm on the basis of a power law of the dielectric constant, has never been observed up to now, while emission bands from the aggregated centers span the visible and the near infrared region with high quantum efficiency. The F absorption band, centered around 240 nm, is located in the UV region, which contains the luminescence excitation bands of several other color centers and shows other interesting features related to excitons absorption. This work reports on the study of the emission induced in LiF crystals colored with gamma rays by pumping the F band with the 284 nm line of a KrF excimer laser.

7779 (ENEA-RT-INN–92-18, pp. 13-15) **Optical gain of F2 and F3 centers in thin and colored layers of LIF.** Cremona, M. (ENEA, Frascati (Italy). Dipt. Sviluppo Tecnologie di Punta); Baldacchini, G.; Montereali, R.M.; Scavarda do Carmo, L.C. ENEA, Frascati (Italy). Dipt. Sviluppo Tecnologie di Punta. Nov 1992. (CONF-920816–: International conference on defects in insulating materials, Nordkirchen (Germany), 16-22 Aug 1992). In *Contributions to International conference on defects in insulating materials.* 19p. Order Number DE93522969. Source: OSTI; NTIS (US Sales Only).

Laser emission in the visible range has been obtained at room temperature in LiF crystals containing F_2 and F_3^+ color centers, which are produced at a concentration of 10^17 cm^{-3} by using ionizing radiations. On the contrary, low energy electrons allow, with their limited penetration depth, the creation of a thin layer with a high concentration of defects located at the surface of the crystalline material. This technique has already been investigated for applications in the area of high density mass memory making use of inhomogeneous broadening on zero-phonon lines. Moreover, the

present trends on miniaturization of opto-electronic devices calls for an exaustive investigation on the optical properties of color centers produced in volumes of sub-micron scale. Therefore, systematic research was undertaken in this direction and this paper reports the first measurements of optical gain at room temperature of F_2 and F_3^+ centers produced in a thin layer of LiF bulk and films.

7780 (ENEA-RT-INN–92-18, pp. 17-19) **KCl films: Photoluminescence of F-aggregate centres.** Somma, F. (Rome Univ. (Italy). Dipt. di Fisica); Ercoli, A.; Scacco, A.; Nunes, R.A.; Cremona, M.; Montereali, R.M.; Scavarda do Carmo, L.C. ENEA, Frascati (Italy). Dipt. Sviluppo Tecnologie di Punta. Nov 1992. (CONF-920816–: International conference on defects in insulating materials, Nordkirchen (Germany), 16-22 Aug 1992). In *Contributions to International conference on defects in insulating materials.* 19p. Order Number DE93522969. Source: OSTI; NTIS (US Sales Only).

Present interest in miniaturization has fostered developments in the area of production and characterzation of thin films. Alkali halide films have been studied with special concern for their optical and electrical properties. Colour centres, created in these films, exhibit optical absorption and emission bands which can be used in optical micro-devices. In this work, large concentrations of F and F-aggregate centres were obtained by electron irradiation on KCl films, and the main features of the photoluminescence properties of the defects were for the first time systematically investigated.

7781 (ORNL/FTR–4759) **Travel to Japan and Greece to attend and present invited talks at the International Union of Materials Research Society – The 3rd International Conference on Advanced Materials: Foreign trip report, August 21, 1993–September 17, 1993.** Geohegan, D.B. Oak Ridge National Lab., TN (United States). 1 Oct 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94000983. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The main purposes of the trip were (1) to present an invited talk at the IUMRS-ICAM 1993 Conference, Tokyo, Japan, entitled "Physics and Diagnostics of Pulsed Laser Deposition Laser Plasmas," (2) to present an invited talk entitled "Time-Resolved Diagnostics of Excimer-Laser Generated Ablation Plasmas: Optical and Ion Probe Studies," at the NATO-ASI Conference in Crete, Greece, and (3) to visit and assess laser ablation facilities in Japan.

6654 Quantum Physics Aspects of Condensed Matter

665410 Superconductivity

Refer also to citation(s) 6934, 6977, 7040, 7269

7782 (ANL–93/33) **Practical superconductor development for electrical power applications: Annual report for FY 1993.** Poeppel, R.B. (Kalamazoo, Coll., MI (United States)); Goretta, K.C. (comp.); Askew, T.R. Argonne National Lab., IL (United States). Oct 1993. 58p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94005378. Source: OSTI; NTIS; GPO Dep.

Development of useful high-critical-temperature superconductors requires synthesis of superconducting compounds; fabrication of wires, tapes, and films from these compounds; production of composite structures that incorporate stabilizers or insulators; and design and testing of efficient components. This report describes technical progress of research and development efforts aimed at producing superconducting components in the Y-Ba-Cu, (Bi,Pb)-Sr-Ca-Cu,(Tl,Pb, Bi)-(Ba,Sr)-Ca-Cu, and Hg-Ba-Ca-Cu-O oxide systems. Topics discussed are synthesis and heat treatment of high-T_c superconductors; formation of monolithic and composite wires, tapes, and coils, characterization of structures and superconducting and mechanical properties; fabrication and properties of films; and development of properties of films; and development of prototype components. Collaborations with industry and academia are documented.

7783 (ANL/ET/CP–81211) **Processing and properties of Ag-clad Bi-2223 tapes.** Balachandran, U. (Argonne National Lab., IL (United States)); Iyer, A.N.; Haldar, P.; Motowidlo, L.R. Argonne National Lab., IL (United States). Nov 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931238–1: 6. US-Japan workshop on superconductivity, Houston, TX (United States), 6-7 Dec 1993). Order Number DE94004603. Source: OSTI; NTIS; GPO Dep.

We prepared partially reacted, polyphase, Pb-doped Bi-Sr-Ca-Cu-O (2223) powders by solid-state and wet-chemical routes. The calcined powders were characterized by thermal analysis, x-ray diffraction, and scanning electron microscopy. We then fabricated long lengths of flexible Ag-clad 2223 tapes by the powder-in-tube technique. Multifilamentary conductors have been prepared by stacking circular single-core Ag-sheathed superconductor rods into larger Ag tube and then drawing and rolling the tube to final size. The tapes were given appropriate heat treatment and the growth of the 2223 phase at each step of the heat treatment was studied. At 4.2 and 27 K, improved process conditions yielded transport critical current density (J_c) values $> 10^5$ A/cm^2 at zero field; at 77 K, J_c exceeded 4×10^4 A/cm^2. Using a two-step rolling with an intermediate heat treatment, we have fabricated conductors ≈70 m long. The J_c value of these long conductors is $\approx 2 \times 10^4$ A/cm^2 at 77 K in self field. Superconducting pancake coils were fabricated from the long-length tapes by the wind-and-react technique.

7784 (ANL/ET/CP–81213) **Recent developments in fabrication of Bi-2223 conductors and magnets.** Balachandran, U. (Argonne National Lab., IL (United States)); Iyer, A.N.; Haldar, P.; Hoehn, J.G. Jr.; Motowidlo, L.R. Argonne National Lab., IL (United States). Dec 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931238–3: 6. US-Japan workshop on superconductivity, Houston, TX (United States), 6-7 Dec 1993). Order Number DE94004628. Source: OSTI; NTIS; GPO Dep.

Significant progress has been made in the fabrication of Bi-2223 high-T_c, high-critical-current-density (J_c) superconductor tapes that are attractive for electrical power and high-field magnet applications. Long lengths (≈100 m) of Ag-clad Bi-2223 tapes with high J_c were fabricated by powder-in-tube technique and used to make compact and robust pancake coils by wind-and-react method. Three to five layers of tapes were co-wound with an insulation and heat treated to produce pancake coils. These coils were then stacked in series to make test magnets. The coils and magnets were characterized at temperatures of liquid nitrogen (77 K), pumped liquid nitrogen (64 K), liquid neon (27 K), and liquid helium (4.2 K). Recently, we assembled a magnet containing ten pancake coils (≈480 m of tape) that generated magnetic fields as high as 2.6, 1.8, 0.53, and 0.36 T at 4.2, 27, 64, and 77 K, respectively. These results show promise toward practical utilization of high-$T_c$materials. Lengths of superconductor, 30–100 m long, are now being made, and 70-m lengths have been measured to carry 23 A (corresponding to $J_c \approx 1.5 \times 10^4$ A/cm^2) at 77 K. Progress in the prototype manufacturing of long lengths of Bi-2223 conductor is discussed in this paper.

7785 (ANL/ET/CP–81504) **Current leads and magnetic bearings.** Hull, J.R. Argonne National Lab., IL (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931238–2: 6. US-Japan workshop on superconductivity, Houston, TX (United States), 6-7 Dec 1993). Order Number DE94004607. Source: OSTI; NTIS; GPO Dep.

Since the discovery of high-temperature superconductors (HTSs), Argonne National Laboratory (ANL) has been active in a broad spectrum of activities in developing these materials for applications. Work at every stage of development has involved industrial collaboration in order to accelerate commercialization. While most of the development work has been devoted to improving the properties of current-carrying wires, some effort has been devoted to applications that can utilize HTSs with properties available now or in the near future. In this paper, I discuss advances made at my laboratory in the area of current leads and magnetic bearings.

7786 (ANL/MSD/CP–80230) **Energy gap structure of layered superconductors.** Liu, S.H. (Oak Ridge National Lab., TN

(United States)); Klemm, R.A. Argonne National Lab., IL (United States); Oak Ridge National Lab., TN (United States). Nov 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38 ; AC05-84OR21400. (CONF-940121--1: Superconducting superlattices and multilayers and oxide superconductory physics and nanoengineering, Los Angeles, CA (United States), 23-28 Jan 1994). Order Number DE94005132. Source: OSTI; NTIS; GPO Dep.

We report the energy gap structure and density-of-states (DOS) of a model layered superconductor with one superconducting layer and one normal layer in a unit cell along the c-axis. In the physically interesting parameter range where the interlayer hopping strengths of the quasiparticles are comparable to the critical temperature, the peaks in the DOS curve do not correspond to the order parameter (OP) of the superconducting layer, but depend on the OP and the band dispersion in the c-direction in a complex manner. In contrast to a BCS superconductor, the DOS of layered systems have logarithmic singularities. Our simulated tunneling characteristics bear close resemblance to experimental results.

7787 (ANL/MSD/CP--81484) **The effect of processing on the microstructure of Ag-sheathed Bi-2223 wires.** Miller, D.J. (Argonne National Lab., IL (United States)); Hu, J.G.; Kostic, P.; Balachandran, U.; Haldar, P. Argonne National Lab., IL (United States). Nov 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931009--15: Fall meeting of the Minerals, Metals and Materials Society: physical metallurgy and materials, Pittsburgh, PA (United States), 17-21 Oct 1993). Order Number DE94004627. Source: OSTI; NTIS; GPO Dep.

Studies using TEM and SEM, focused on effect of final heat treatment conditions on microstructure of $(Bi,Pb)_2Sr_2Ca_2Cu_3O_x$(Bi-2223)wires and corresponding variations in critical currents (I_c). It is found that variations in I_c for segments cut from various points along length of a wire can be correlated with variations in volume fraction and nature of second phases. Similar variations are observed between wires processed under different final annealing conditions. A common feature found in all of the wire segments with lower I_c values was presence of the $Pb_3Sr_2Ca_2CuO_x$ phase (Pb-3221). Microchemical analysis suggests that formation of this phase leads to variations in composition of Bi-2223 grains. As a result, the wires which exhibit the Pb-3221 phase consist of an assemblage of grains with a range of transition temperatures based on composition. Thus, in these segments, the current carrying capacity of individual grains at 77K varies from very good to poor, and a significant reduction in the overall I_c of the segment is observed.

7788 (BNL--49706) **Ac losses for the self field of an ac transport current with a dc transport current offset in high $T_c$superconducting magnet coils for MagLev application.** Koosh, V.F. Brookhaven National Lab., Upton, NY (United States). Oct 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE94005187. Source: OSTI; NTIS; GPO Dep.

Although much research has been conducted concerning the losses of high-$T_c$superconductors, very little has concentrated on the self-field losses in an actual magnet arrangement. The coils studied in this work were designed for use as actual magnets in an industrial application. Self field loss measurements were made upon tape-wound 2223 superconducting helix coils. The self-field losses were produced by an AC transport current with a DC transport current offset. Losses were taken for single, double and triple tape windings, giving essentially monofilament, dual, and three filament cases. The losses measured here were varied over a range of AC current values for several different DC values, and over a range of frequencies. The currents were all AC sinusoids with a DC offset. All measurements were made at T = 77K.

7789 (DOE/ER/14017--5) **Flux flow, pinning, and resistive behavior in superconducting networks: Annual progress report, May 1, 1993--April 30, 1994.** Teitel, S. Rochester Univ., NY (United States). Dept. of Physics and Astronomy. Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER14017. Order Number DE94003400. Source: OSTI; NTIS; INIS; GPO Dep.

We have studied the behavior of fluctuation effects in superconducting systems using numerical simulations of XY and Coulomb gas models. The fluctuation of vortex lines in high temperature superconductors, in the presence of an external magnetic field, has been studied using a three dimensional XY model. We have continued earlier work and verified the existence of two distinct phase transitions in this model. As the vortex line lattice is heated, it melts first into a line liquid where superconductivity is destroyed for currents perpendicular to the applied magnetic field, but persists for currents parallel to the field. As heating continues, the thermal excitation of closed vortex line loops links all the lines together, leading to completely normal metal properties in all directions. Upon cooling of the vortex line liquid, we find that as the system width increases, one can get trapped into an entangled non-equilibrium state in which vortex line cuttings are frozen out on measurable nine scales. We have also continued simulations of the two dimensional Coulomb gas, as a model for vortex fluctuations in two dimensional arrays of Josephson junctions, and thin film superconductors. Our preliminary results support the accepted view of a Kosterlitz-Thouless melting of the vortex lattice, in the limit of a uniform continous film.

7790 (IS-T--1642) **Synthesis, rheology and forming of Y-Ba-Cu-O ceramics.** Green, T.M. Ames Lab., IA (United States). Jul 1993. 145p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005558. Source: OSTI; NTIS; INIS; GPO Dep.

A chemical synthesis route is discussed which results in a low-temperature precursor to Y-Ba-Cu-O ceramics; it is based on use of molten $Ba(OH)_2{\cdot}8H_2O$ flux. Two different chemical systems have been examined; the first one, based on nitrate salts, has been demonstrated to be a viable precursor material for tape casting and extrusion; the second, made from acetate salts, has been used for powder synthesis and extrusion. Rheology of pastes shows that their flow may be fit to either Bingham Plastic or Hershel- Bulkley models. Yield stress is controlled in both pastes by volume fraction solids. Viscosity also follows solids loading in the paste. Shear thinning is controlled by colloidal nature of precursor. The paste has colloidal microstructure. Comparison of concentric cylinder rheometry and piston extrusion rheometry shows order of magnitude differences in yield stress, resulting from the test method and paste dilation.

7791 **Free-standing superconductive articles.** Wu, X.D.; Muenchausen, R.E. To Dept. of Energy. 1991. U.S. patent application 7-813,727. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005157. Source: OSTI; NTIS; GPO Dep.

A substrate-free, free-standing epitaxially oriented superconductive film including a layer of a template material and a layer of a ceramic superconducting material is provided together with a method of making such a substrate-free ceramic superconductive film by coating an etchable material with a template layer, coating the template layer with a layer of a ceramic superconductive material, coating the layer of ceramic superconductive material with a protective material, removing the etchable material by an appropriate means so that the etchable material is separated from a composite structure including the template layer, the ceramic superconductive material layer and the protective material layer, removing the protective material layer from the composite structure whereby a substrate-free, free-standing ceramic superconductive film remains.

7792 **Superconductive articles.** Wu, X.D.; Muenchausen, R.E. To Dept. of Energy. 1991. U.S. patent application 7-814,355. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94005152. Source: OSTI; NTIS; GPO Dep.

An article of manufacture including a substrate, a patterned interlayer of magnesium oxide, barium-titanium oxide or barium-zirconium oxide, the patterned interlayer material overcoated with a secondary interlayer material of yttria-stabilized zirconia or magnesium-aluminum oxide, upon the surface of the substrate whereby an intermediate article with an exposed surface of both the overcoated patterned interlayer and the substrate is formed, a

coating of a buffer layer selected from the group consisting of oxides of Ce, Y, Cm, Dy, Er, Eu, Fe, Gd, Ho, In, La, Mn, Lu, Nd, Pr, Pu, Sm, Tb, Tl, Tm, Y, and Yb over the entire exposed surface of the intermediate article, and, a ceramic superconductive material layer as an overcoat upon the buffer layer whereby the ceramic superconductive material situated directly above the substrate has a crystal structure substantially different than the ceramic superconductive material situated above the overcoated patterned interlayer.

70 PLASMA PHYSICS AND FUSION

7003 Plasma Physics and Fusion Research

Refer also to citation(s) 7559, 7869, 7948

7793 (BUDKERINP–91-116) **Multiple mirror plasma confinement.** Mirnov, V.V.; Lichtenberg, A.J. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1991. 119p. (IYaF–91-116.). Order Number DE94611442. Source: OSTI; NTIS (US Sales Only); INIS.

Multiple mirror plasma confinement concept is considered. A theory of plasma diffusion through a corrugated magnetic field is developed. It is shown, that multiple mirror devices hold considerable promise for confining fusion plasmas. 75 refs.; 8 figs.; 4 tabs.

7794 (BUDKERINP–92-58) **Self-similar regimes of subsonic Langmuir wave collapse.** Khudik, V.N.; Malkin, V.M. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1992. 9p. (IYaF–92-58.). Order Number DE94611466. Source: OSTI; NTIS (US Sales Only); INIS.

The first examples of regular and singular self-similar solutions of the 3-d nonlinear Schroedinger equation for potential vector field are found explicitly. Regular solutions relate to the process of the 'singularities ' formation. Singular solutions relate to an early evolution of the 'singularities'. Together, the solutions describe behaviour of Langmuir wave field in the spatiotemporal vicinities of its'singularities' and provide an effective mechanism of energy dissipation from the Langmuir condensate. 5 refs.; 1 fig.

7795 (BUDKERINP–92-60) **The kinetics of inhomogeneous plasma.** Erofeeev, V.I. AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki. 1992. 20p. (IYaF–92-60.). Order Number DE94611459. Source: OSTI; NTIS (US Sales Only); INIS.

A new concept of plasma kinetic description is developed. The instrumentation was elaborated for describing of plasma cross diffusion via the particle interaction with drift waves. The instrumentation includes consistent equations of particle distribution evolution and of drift wave pumping. The effect of plasma nonstationary and particle induced scattering are taken into account. The new concept do not involve the averaging over the initial data ensemble. In treating of turbulent plasma it gives possibilities to avoid the using of the wellknown Random Phase Approximation and of any renormalizations. 10 refs.

7796 (CONF-9311140–1) **Fast wave current drive technology development at ORNL.** Baity, F.W. (Oak Ridge National Lab., TN (United States)); Batchelor, D.B.; Goulding, R.H.; Hoffman, D.J.; Jaeger, E.F.; Ryan, P.M.; deGrassie, J.S.; Petty, C.C.; Pinsker, R.I.; Prater, R. Oak Ridge National Lab., TN (United States). [1993]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From IAEA meeting on radio-frequency launchers for plasma heating and current drive; Naka (Japan); 10-12 Nov 1993. Order Number DE94004243. Source: OSTI; NTIS; INIS; GPO Dep.

The technology required for fast wave current drive (FWCD) systems is discussed. Experiments are underway on DIII-D, JET, and elsewhere. Antennas for FWCD draw heavily upon the experience gained in the design of ICRF heating systems with the additional requirement of launching a directional wave spectrum. Through collaborations with DIII-D, JET, and Tore Supra rapid progress is being made in the demonstration of the physics and technology of FWCD needed for TPX and ITER.

7797 (CONF-9311147–1) **Helium transport and exhaust studies of H-mode discharges in the DIII-D tokamak.** Hillis, D.L. (Oak Ridge National Lab., TN (United States)); Wade, M.R.; Hogan, J.T. Oak Ridge National Lab., TN (United States); General Atomics, San Diego, CA (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400 ; AC03-89ER51114. From IAEA meeting on H-mode physics; Naka (Japan); 15-17 Nov 1993. Order Number DE94004744. Source: OSTI; NTIS; INIS; GPO Dep.

A collaborative program has been initiated to measure helium (He) transport and exhaust on DIII-D in L-mode, ELM-free H-mode, and ELMing H-mode. These diverted plasmas operating in enhanced confinement regimes should provide valuable information for the International Thermonuclear Experimental Reactor (ITER). To simulate the presence of He ash in DIII-D, a 50 ms He puff is injected into a DIII-D plasma, resulting in a He concentration of ~ 15%. The time dependence of the He density profiles in the plasma core is measured with charge-exchange recombination spectroscopy and the He spatial distribution on the diverter floor is studied with an impurity monitor array. The dependence of core transport diffusivities as a function of ELM frequency have been studied and the first demonstration made of He exhaust from an H-mode plasma in a diverted tokamak. The exhaust rate of He from these ELMing H-mode plasmas appears to be within the acceptable range for a fusion reactor, like ITER, based on a measured value of $\tau^*_{He}/\tau E \approx 14$.

7798 (DOE/ER/53198–227) **Measurement of magnetic fluctuation induced energy transport.** Fiksel, G.; Prager, S.C.; Shen, W.; Stoneking, M. Wisconsin Univ., Madison, WI (United States). Dept. of Physics. Nov 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-85ER53198. Order Number DE94003846. Source: OSTI; NTIS; INIS; GPO Dep.

The local electron energy flux produced by magnetic fluctuations has been measured directly in the MST reversed field pinch (over the radial range $r/a > 0.75$). The flux, produced by electrons traveling parallel to a fluctuating magnetic field, is obtained from correlation between the fluctuations in the parallel heat flux and the radial magnetic field. The fluctuation induced flux is large (100 kW/cm^2) in the "core" ($r/a < 0.85$) and small (< 10–30 kW/cm^2) in the edge.

7799 (DOE/ER/53198–229) **Broadband EUV survey spectrometer for short-timescale experiments.** Chapman, B.E.; Hartog, D.J. Den; Fonck, R.J. Wisconsin Univ., Madison, WI (United States). Plasma Physics Research. Nov 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-85ER53198. Order Number DE94005459. Source: OSTI; NTIS; INIS; GPO Dep.

A fast and inexpensive spectrometer system has been developed to record EUV impurity spectra in a magnetic fusion research device. To simplify the vacuum system, light is passed out of the spectrometer's vacuum to the detector using a sodium-salicylate-coated fiber optic coupler. This coupler is positioned such that the focal field is nearly flat over its aperture. The system's detector is a microchannel-plate-intensified, linear, self-scanning photodiode array. The 1024-pixel array covers a bandwidth of over 80 nm and is read out once every millisecond. The readout, which is four times faster than the manufacturer's maximum rating, is fully synchronized to the experiment using a locally-designed control circuit.

7800 (DOE/ER/53198–230) **Photon counting spectroscopy as done with a Thomson scattering diagnostic.** Den Hartog, D.J.; Ruppert, D.E. Wisconsin Univ., Madison, WI (United States). Plasma Physics Research. Nov 1993. 48p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-85ER53198. Order Number DE94005543. Source: OSTI; NTIS; INIS; GPO Dep.

The measurement and reduction of photon counting spectral data is demonstrated within the context of a Thomson scattering diagnostic. This diagnostic contains a microchannel plate (MCP) photomultiplier tube (PMT) as the photon sensing device. The MCP PMT is not an ideal photon sensor, the loss of photoelectrons at the MCP input and the broad charge pulse distribution at the output add to the uncertainty in recorded data. Computer simulations are used to demonstrate an approach to quantification of this added uncertainty and to develop an understanding of its source; the methodology may be applicable to the development of an

understanding of photon detectors other than an MCP PMT. Emphasis is placed on the Poisson statistical character of the data, because the assumption that a Gaussian probability distribution is a reasonable statistical description of photon counting data is often questionable. When the count rate is low, the product the possible number of photon counts and the probability of measurement of a single photon is usually not sufficiently large to justify Gaussian statistics. Rather, because probabilities of measurement are so low, the Poisson probability distribution best quantifies the inherent statistical fluctuations in such counting measurements. The method of maximum likelihood is applied to derive the Poisson statistics equivalent of $_{\chi}{}^{2}$. A Poisson statistics based data fitting code is implemented using the Newton-Raphson method of multi-dimensional root finding; we also demonstrate an algorithm to estimate the uncertainties in derived quantities.

7801 (DOE/ER/53198–231) **Fluctuation and transport reduction in a reversed field pinch by inductive poloidal current drive.** Sarff, J.S.; Hokin, S.A.; Ji, H.; Prager, S.C.; Sovinec, C.R. Wisconsin Univ., Madison, WI (United States). Plasma Physics Research. Dec 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-85ER53198. Order Number DE94005542. Source: OSTI; NTIS; INIS; GPO Dep.

An auxilliay poloidal inductive electric field applied to a reversed field pinch plasma reduces the current density gradient, slows the growth of m=1 tearing fluctations, suppresses their associated sawteeth, and doubles the energy confinement time. Small sawteeth occur in the improved state but with m=0 precursors. By requiring a change of toroidal flux embedding the plasma, inductive poloidal current profile drive is transient, but the improvement encourages the program of RFP transport suppression using current profile control.

7802 (DOE/ER/53211–12) **[Advanced development of particle beam probe diagnostic system]: Annual progress report, [15 December 1992–15 October 1993].** Crowley, T.P.; Schoch, P.M.; Connor, K.A. Rensselaer Polytechnic Inst., Troy, NY (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-85ER53211. Order Number DE94002316. Source: OSTI; NTIS; INIS; GPO Dep.

This progress report under DOE Grant DE-FG02-85ER3211 covers the period 15 December 1992 through 15 October 1993. The major accomplishments of this period are summarized below: The basic TEXT heavy ion beam probe including the primary beam line, the upper secondary beam line with the old 500 keV analyzer, and the lower secondary beam line with the new 2 MeV analyzer is operational and system shake-down is now beginning. Several subsystems of the complete system design are still under development, including secondary beam line sweeps, primary beam detectors, the digital control and data acquisition system. The lower analyzer entrance aperture and detector plates also have very limited capabilities to make it possible to more rapidly obtain satisfactory initial alignment and calibration conditions. We have performed a variety of high voltage tests that establish the basic efficacy of the 2 MeV analyzer design. We have upgraded the ion optics and added vacuum chambers in our vertical test stand facility to allow us to test the 2 MeV analyzers. We have also constructed a facility for testing ion source characteristics. We analyzed data on primary beam modulation taken during the last run period and confirmed the accuracy of our simulation code. Analysis of magnetic field measurements continued.

7803 (DOE/ER/53212–T2) **Theoretical reversed field pinch and tokamak studies: Progress report, November 1, 1992–June 10, 1993.** Wisconsin Univ., Madison, WI (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-85ER53212. Order Number DE94005409. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the following topics: fluctuation suppression by electrostatic current injection; pulsed poloidal current drive; effect of current drive on fluctuations; rf current drive in the RFP; development of a hyper-dissipation algorithms; and interacting magnetic islands.

7804 (DOE/ER/53222–108) **Passive stabilization of MHD instabilities at high βn in the HBT-EP Tokamak.** Gates, D.A. Columbia Univ., New York, NY (United States). Plasma Physics Lab. 1993. 133p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER53222. Order Number DE94003317. Source: OSTI; NTIS; INIS; GPO Dep.

The HBT-EP Tokamak has been designed, built, and is now fully operational in the Columbia University Plasma Physics Laboratory. One of the primary purposes of this facility is to study the effects of a conducting wall on the MHD modes that lead up to plasma disruptions. Of particular interest are the types of instabilities that are driven by the kinetic pressure of the plasma, because these instabilities are believed to be responsible for the present limit to plasma β with $\beta \propto \langle p \rangle / B^2$, where the $\langle p \rangle$ is the volume averaged pressure and B is the magnetic field. To this end, a movable conducting wall has been installed inside the HBT-EP vacuum chamber. The primary result of this thesis are the initial results from experiments that study the effect of this wall on plasma instabilities. The experiment shows that the conducting wall significantly reduces the growth rate of instabilities that precede a plasma disruption that occurs when the value of β is near the Troyon limit. The location of the wall required for significant stabilization is b/a $\sim$1.2 where a is the minor radius of the plasma and b is the minor radial location of the wall. Moving the wall closer than b/a = 1.2 slightly degrades the stabilizing effect, which is consistent with recent theories.

7805 (DOE/ER/53237–T1) **Determination of atomic data pertinent to the Fusion Energy Program: Progress report for FY 92.** National Inst. of Standards and Technology, Gaithersburg, MD (United States). [1992]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI05-86ER53237. Order Number DE94004400. Source: OSTI; NTIS; INIS; GPO Dep.

In the pursuit of the general goal to provide essential atomic radiation and collision data for the fusion energy program, the following progress was achieved at NIST during FY 92: (1) identification of spectral lines of impurity in ions (from Er to Bi); (2) spectroscopic data compilations of critically evaluated wavelengths and energy levels of atoms and ions; (3) electron-ion collision experiments; (4) electron impact excitation theory; and (5) electron-impact ionization theory.

7806 (DOE/ER/53281–T1) **The investigation of electron-ion radiative and dielectronic recombination in high-temperature plasmas: Progress report for 1989–1990.** Jacobs, V.L. Naval Research Lab., Washington, DC (United States). Condensed Matter and Radiation Sciences Div. [1990]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI05-89ER53281. Order Number DE94004907. Source: OSTI; NTIS; INIS; GPO Dep.

(1) The unified description of radiative and dielectronic recombination has been extended to treat processes involving more than a single state of the initial ion, the autoionizing resonance, and the recombined ion. The major theoretical effort is now centered on the generalization of this description to self-consistently incorporate the effects of charged-particle collisions and plasma electric fields. (2) The K_{α} model for the dielectronic satellite spectra of highly-charged Fe ions has been incorporated into the multi-ion-species transport code developed at the Princeton Plasma Physics Laboratory. The immediate objective is to produce a realistic simulation of the observed Fe K_{α} spectra from PLT and TFTR. (3) A detailed investigation is in progress involving calculations of the dielectronic recombination satellite spectra in the presence of a distribution of plasma electric microfields. The calculations have been carried out for the lowest-lying n=2 satellites, which are affected by the electric fields only in high-density laser-produced plasmas. (4) The investigation has been completed on the effects of indirect processes involving autoionization resonances for electron-density sensitive line-intensity ratios. The resonance contributions have been found to be comparable with the direct electron-impact excitation rates for magnetic-quadrupole transitions in high-charged ions. Line intensity ratios have been identified which are sensitive to density in the density region of characteristic tokamak plasmas.

7807 (DOE/ER/53281–T2) **The investigation of electron-ion radiative and dielectronic recombination in high-temperature plasmas: Progress report for 1990–1991.** Jacobs, V.L. Naval Research Lab., Washington, DC (United States). Condensed Matter and Radiation Sciences Div. [1991]. 5p. Sponsored by USDOE,

Washington, DC (United States). DOE Contract AI05-89ER53281. Order Number DE94005149. Source: OSTI; NTIS; INIS; GPO Dep.

(1) The unified description of radiative and dielectronic recombination, which the authors have developed to provide corrections to the conventional independent-processes approximation, has been generalized to self-consistently incorporate the effects of charged-particle collisions and plasma electric fields. (2) The K_α model for the dielectronic satellite spectra of highly-charged Fe ions, which the authors have developed based on the conventional theory of dielectronic satellite line intensities, has been incorporated into the multi-ion-species transport code MIST. Excellent agreement has been obtained between the simulated spectra and the observed Fe K_α spectra from PLT and TFTR. (3) A detailed investigation has been completed on the dielectronic recombination satellite spectra in the presence of a distribution of plasma electric microfields. The calculations have been carried out for the lowest-lying n=2 satellites, which are affected by the electric fields only in high-density laser-produced plasma. For application to the lower-density conditions in tokamak plasmas, in which the electron density is about ten orders of magnitude smaller, a number of alternatives are under consideration for evaluating the recombination rates associated with the Rydberg autoionizing sates corresponding to large values of n. (3) A manuscript entitled "Observation of Density-Enhanced Dielectronic Satellite Spectra Produced During Subpicosecond Laser-Matter Interactions" has been submitted for publication in the Physical Review A. This work provides a convincing experimental verification of the theoretical predictions on the density sensitivity of diagnostically-important dielectronic satellite spectra in dense plasmas.

7808 (DOE/ER/53281–T3) **The investigation of electron-ion radiative and dielectronic recombination in high-temperature plasmas: Progress report for 1992–1993.** Jacobs, V.L. Naval Research Lab., Washington, DC (United States). Condensed Matter and Radiation Sciences Div. [1993]. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI05-89ER53281. Order Number DE94005150. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes progress covered in the following six areas: (1) unified description of radiative and dielectronic recombination; (2) calculations of specific dielectronic satellite transitions; (3) Modeling of K_α dielectronic satellite spectra; (4) effects of electron collisions and electric fields; (5) density-sensitive dielectronic satellite lines; and (6) polarization of atomic radiative emission in crossed electric and magnetic fields. Also discussed are proposed investigations and coordination with current tokamak observations.

7809 (DOE/ER/53291–225) **The dynamics of interacting nonlinearities governing long wavelength driftwave turbulence.** Newman, D.E. Wisconsin Univ., Madison, WI (United States). Plasma Physics Research. Sep 1993. 107p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER53291. Order Number DE94001785. Source: OSTI; NTIS; INIS; GPO Dep.

Because of the ubiquitous nature of turbulence and the vast array of different systems which have turbulent solutions, the study of turbulence is an area of active research. Much present day understanding of turbulence is rooted in the well established properties of homogeneous Navier-Stokes turbulence, which, due to its relative simplicity, allows for approximate analytic solutions. This work examines a group of turbulent systems with marked differences from Navier-Stokes turbulence, and attempts to quantify some of their properties. This group of systems represents a variety of drift wave fluctuations believed to be of fundamental importance in laboratory fusion devices. From extensive simulation of simple local fluid models of long wavelength drift wave turbulence in tokamaks, a reasonably complete picture of the basic properties of spectral transfer and saturation has emerged. These studies indicate that many conventional notions concerning directions of cascades, locality and isotropy of transfer, frequencies of fluctuations, and stationarity of saturation are not valid for moderate to long wavelengths. In particular, spectral energy transfer at long wavelengths is dominated by the E x B nonlinearity, which carries energy to short scale in a manner that is highly nonlocal and anisotropic. In marked contrast to the canonical self-similar cascade dynamics of Kolmogorov, energy is efficiently passed between modes separated by the entire spectrum range in a correlation time. At short wavelengths, transfer is dominated by the polarization drift nonlinearity. While the standard dual cascade applies in this subrange, it is found that finite spectrum size can produce cascades that are reverse directed and are nonconservative in enstrophy and energy similarity ranges. In regions where both nonlinearities are important, cross-coupling between the nolinearities gives rise to large no frequency shifts as well as changes in the spectral dynamics.

7810 (DOE/ER/54111–3) **Heavy Neutral Beam Probe for edge plasma analysis in Tokamaks: Annual progress report, December 1, 1992–November 30, 1993.** Castracane, J.; Saravia, E.; Beckstead, J.; Aceto, S. InterScience, Inc., Troy, NY (United States). 3 Sep 1993. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER54111. Order Number DE94003391. Source: OSTI; NTIS; INIS; GPO Dep.

The contents of this report present the progress achieved to date on the Heavy Neutral Beam Probe project. This effort is an international collaboration in magnetic confinement fusion energy research sponsored by the US Department of Energy, Office of Energy Research (Confinement Systems Division) and the Centre Canadien de Fusion Magnetique (CCFM). The overall objective of the effort is to develop and apply a neutral particle beam to the study of edge plasma dynamics in discharges on the Tokamak de Varennes (TdeV) facility in Montreal, Canada. To achieve this goal, a research and development project was established to produce the necessary hardware to make such measurements and meet the scheduling requirements of the program. At present the project is in the middle of its second budget period with the instrumentation on-site at TdeV. The first half of this budget period was used to complete total system tests at InterScience, Inc., dismantle and ship the hardware to TdeV, re-assemble and install the HNBP on the tokamak. Integration of the diagnostic into the TdeV facility has progressed to the point of first beam production and measurement on the plasma. At this time, the HNBP system is undergoing final de-bugging prior to re-start of machine operation in early Fall of this year.

7811 (DOE/ER/54139–2) **TFTR Experimental Data Analysis Collaboration: Annual progress report, November 15, 1992–November 14, 1993.** Callen, J.D. Wisconsin Univ., Madison, WI (United States). [1993]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER54139. Order Number DE94004166. Source: OSTI; NTIS; INIS; GPO Dep.

The research performed under the second year of this three-year grant has concentrated on a few key TFTR experimental data analysis issues: MHD mode identification and effects on supershots; identification of new MHD modes; MHD mode theory-experiment comparisons; local electron heat transport inferred from impurity-induced cool pulses; and some other topics. Progress in these areas and activities undertaken in conjunction with this grant are summarized briefly in this report.

7812 (DOE/ER/54196–1) **TFTR Ion Cyclotron Range of Frequencies (ICRF) experimental data analysis collaboration: Annual progress report, December 1, 1992 to November 30, 1993.** Scharer, J.E. Wisconsin Univ., Madison, WI (United States). Dept. of Electrical and Computer Engineering. Dec 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-93ER54196. Order Number DE94004699. Source: OSTI; NTIS; INIS; GPO Dep.

The research performed under this grant during the past year has been concentrated on two TFTR tokamak ICRF (Ion Cyclotron Range of Frequencies) coupling, and heating issues. This includes a "3-D" coupling analysis of the TFTR ICRF cavity-backed coil antennas to plasma edge profiles including the Faraday shield blade angle and fast wave coupling for heating and current drive; TFTR ICRF full-wave field solutions, heating analyses for the D-T supershot; and the effects of fusion alpha particle and ion tail populations on the ICRF absorption. Research progress, publications, and conference presentations are summarized in this report.

7813 (DOE/ER/54197–1) **Maryland controlled fusion research program: Progress report, November 1, 1992–October 31, 1993.** Antonsen, T.M. Jr.; Drake, J.F.; Finn, J.M.; Guzdar, P.;

Hassam, A.; Liu, C.S.; Ott, E. Maryland Univ., College Park, MD (United States). May 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-93ER54197. Order Number DE94003533. Source: OSTI; NTIS; INIS; GPO Dep.

In recent years, members of the Maryland Plasma Theory Group have made significant contributions to the national fusion theory program, and, in many cases, these theoretical developments helped to interpret experimental results and to design new experimental programs. In this paper, we summarize the technical progress in four major areas of tokamak research: (a) L/H transition and edge turbulence and transport; (b) active control of micro-turbulence and transport; (c) major disruptions; and (d) the sawtooth crash.

7814 (DOE/ET/53088–623-Rev.) **Kinetic resonance damping rate of the toroidal ion temperature gradient mode.** Kim, J.Y.; Kishimoto, Y.; Horton, W.; Tajima, T. Texas Univ., Austin, TX (United States). Inst. for Fusion Studies. Nov 1993. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-80ET53088. (IFSR–623-Rev.). Order Number DE94003511. Source: OSTI; NTIS; INIS; GPO Dep.

The linear damping rates of the toroidal ion temperature gradient (η_i) mode due to the toroidal resonance are calculated in the local kinetic limit. The well-known Landau contour method is generalized to treat the analytic continuation problem of the guiding center dispersion function in the toroidal resonance system where the resonance occurs from both the magnetic ∇B-curvature drift and the parallel ion transit drift. A detailed numerical analysis is presented for the dependence of the damping rate of the toroidal η_i mode on various parameters such as ϵ_n, κ_y, and the rapped electron fraction. In addition, a consideration is presented on the decay problem of the ballistic response by phase mixing in the toroidal system, which is directly related to the kinetic damping problem of the wave normal modes by the toroidal resonance.

7815 (DOE/ET/53088–627) **Toroidal plasma beta-FLR limit in a toroidally linked mirror system.** Wong, H.V. (Texas Univ., Austin, TX (United States). Inst. for Fusion Studies); Berk, H.L.; Ilgisonis, V.I.; Pastukhov, V.P. Texas Univ., Austin, TX (United States). Inst. for Fusion Studies. Oct 1993. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-80ET53088. (IFSR–627). Order Number DE94003119. Source: OSTI; NTIS; INIS; GPO Dep.

The ballooning stability limit in one toroidal section of the recently proposed toroidally linked neutron source is investigated taking into account finite Larmor radius effects. The ideal ballooning instability limits the toroidal plasma beta to less than 1% for a reasonable set of design parameters. The inclusion of stabilizing kinetic effects predicts an improvement in the toroidal plasma beta limit to ~2%.

7816 (DOE/ET/53088–629) **δf Algorithm.** Denton, R.E. (Dartmouth Coll., Hanover, NH (United States). Dept. of Physics and Astronomy); Kotschenreuther, M. Texas Univ., Austin, TX (United States). Inst. for Fusion Studies. Nov 1993. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-80ET53088. (IFSR–629). Order Number DE94003120. Source: OSTI; NTIS; INIS; GPO Dep.

The δf Algorithm is a low noise particle code algorithm. The perturbation of the distribution function (δf) away from a large equilibrium is evolved rather than the total distribution function. "Particles" in the code are actually Lagrangian markers at which the value of the distribution functalon is known. The magnitude of the numerical noise is characteristic of the size of the perturbation rather than the equilibrium, and scales roughly as the inverse of the number of particles. In this paper. the algorithm is described. and conserved energies are derived for linear and nonlinear sets of equations. Two different forms of the energy principle test separately adequate resolution in time and space and adequacy of the number of simulation particles. A semi-implicit time step method is described which allows violation of the Courant condition. Low noise capabilities of a linear code using the algorithm are demonstrated.

7817 (DOE/ET/53088–632) **Reduced Braginskii equations.** Yagi, M. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Horton, W. Texas Univ., Austin, TX (United States). Inst. for Fusion Studies. Nov 1993. 12p. Sponsored by USDOE, Washington, DC (United States);Joint Inst. for Fusion Theory, Austin, TX (United States). DOE Contract FG05-80ET53088. (IFSR–632). Order Number DE94003510. Source: OSTI; NTIS; INIS; GPO Dep.

A set of reduced Braginskii equations is derived without assuming flute ordering and the Boussinesq approximation. These model equations conserve the physical energy. It is crucial at finite β that we solve the perpendicular component of Ohm's law to conserve the physical energy while ensuring the relation $\nabla \cdot j = 0$.

7818 (DOE/ET/53088–T4) **Shear flow generation from the interaction of neoclassical and drift wave transport processes.** Su, X.N.; Yushmanov, P.N.; Dong, J.Q.; Horton, W. Texas Univ., Austin, TX (United States). Inst. for Fusion Studies. Oct 1993. 49p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-80ET53088. Order Number DE94003135. Source: OSTI; NTIS; INIS; GPO Dep.

Self-consistent shear flow generation from the interaction of neoclassical and drift wave turbulence effects is investigated. The neoclassical poloidal flow damping is shown to compete with the flow generation driven by the divergence of the Reynolds stress. When there is no external driving force except for the free energy released from toroidal shear flow, the turbulent fluctuations occur as a transient pulse which takes the system along an equilibrium path to a relaxed state. External torques, such as parallel neutral beam injection, are needed to maintain significant fluctuation levels. For a system driven by a fixed ion temperature gradient, although linearly the poloidal shear flow generated substantially reduces the growth rate, the simulation results show that a sequence of nonlinear pulses occurs that eventually build the fluctuations up to a level that is not significantly affected by the poloidal flow. In this new, highly nonlinear state the transport is intermittent occurring through a sequence of pulses of duration 100 L_n/c_s for typical parameters.

7819 (DOE/FTR–93017803) **Travel to Japan for workshop on RF Heating and Current Drive in Confinement Systems Tokamaks: Foreign trip report, November 16–22, 1991.** Bonoli, P.T. Massachusetts Inst. of Tech., Cambridge, MA (United States). [1991]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-78ET51013. Order Number DE93017803. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report summarizes important results and conclusions of the US-Japan Workshop on RF Heating and Current Drive in Confinement Systems Tokamaks. Three general categories of papers were given and are reported on: (a) RF physics, technology, and applications; (b) New concepts including helicity injection and transport; (c) Scrape off layer and divertor conditions in the presence of RF heating and current drive.

7820 (DOE/FTR–93040088) **Travel to Caderache, France for visit with the Lower Hybrid Current Drive Modeling Group: Foreign trip report, June 19–28, 1993.** Jones, S. Massachusetts Inst. of Tech., Cambridge, MA (United States). Plasma Fusion Center. 1 Sep 1993. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-78ET51013. Order Number DE93040088. Source: OSTI; NTIS (US Sales Only); GPO Dep.

From June 21, 1993 to June 25, 1993, Stephen Jones visited Tore Supra at Caderache, France, for a collaborative visit with the Lower Hybrid Current Drive Modeling group. Stephen Jones is a post-doctoral research fellow with MIT who has been a resident visitor at PPPL for the past 18 months. During this time he has worked on PBX-M with the 2-D hard x-ray imaging system conducting fast electron transport studies. The purpose of this trip was to extend our existent calculation for a fast electron diffusion coefficient by applying a different theoretical model to our x-ray data. Prior to this trip, the theoretical pardon of this calculation was based on the analytic model of Rax and Moreau, yielding a best-fit upper bound for an effective diffusion constant of $D^* = 1.2\ m^2/sec$. Many sensitivity studies were conducted with this model, testing the accuracy of the result. Nevertheless, further testing was desired by applying a completely different theoretical model to the same data. A fully 3-D Fokker-Planck code at Tore-Supra provides an alternative model, and the purpose of a collaborative visit was to couple their code with our data.

7821 (DOE/FTR–94002467) **Travel to Russia for research on vacuum ultraviolet spectra of plasma generators for Tokamak disruption simulations: Foreign trip report, September 12–October 15, 1993.** Rockett, P.D. Sandia National Labs., Albuquerque, NM (United States). 27 Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94002467. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Two identical transmission grating spectrometers were installed on disruption simulation chambers at both plasma research laboratories. Joseph T. Bradley III, UNM and John A. Hunter, SNL conducted the experiments at St. Petersburg and at Troitsk, respectively. Time integrated spectra were recorded on graphite and copper samples at the Vika laboratory while time integrated and time resolved spectra were recorded at 2MK-200 on graphite, tungsten and boron nitride samples. I visited each facility for a week to review the experimental configuration, to evaluate the validity of the data, and to direct the final weeks of data collection. At the conclusion of this trip I attended the 6th International Fusion Reactor Materials Conference in Stresa, Italy where I presented a paper on disruption simulations.

7822 (DOE/OR/00033–T565) **Experimental and numerical investigation of shock wave propagation through complex geometry, gas continuous, two-phase media.** Liu, J. Chien-Chih (California Univ., Berkeley, CA (United States)). Oak Ridge Associated Universities, Inc., TN (United States); California Univ., Berkeley, CA (United States). 1993. 294p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76OR00033. Order Number DE94001408. Source: OSTI; NTIS; INIS; GPO Dep.

The work presented here investigates the phenomenon of shock wave propagation in gas continuous, two-phase media. The motivation for this work stems from the need to understand blast venting consequences in the HYLIFE inertial confinement fusion (ICF) reactor. The HYLIFE concept utilizes lasers or heavy ion beams to rapidly heat and compress D-T targets injected into the center of a reactor chamber. A segmented blanket of failing molten lithium or Li_2BeF_4 (Flibe) jets encircles the reactors central cavity, shielding the reactor structure from radiation damage, absorbing the fusion energy, and breeding more tritium fuel.

7823 (GA-A–21286) **Review of tokamak experiments on direct electron heating and current drive with fast waves.** Pinsker, R.I. General Atomics, San Diego, CA (United States). Dec 1993. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. (CONF-9304112–24: 10. topical conference on radio frequency power in plasmas, Boston, MA (United States), 1-3 Apr 1993). Order Number DE94004185. Source: OSTI; NTIS; INIS; GPO Dep.

Results from tokamak experiments on direct electron interaction with the compressional Alfven wave ('fast wave') are reviewed. Experiments aimed at electron heating as well as those in which fast wave electron current drive was investigated are discussed. A distinction is drawn between experiments employing the lower hybrid range of frequencies, where both the lower hybrid wave ('slow wave') and the fast wave can propagate in much of the plasma, and those experiments using the fast wave in the range of moderate to high ion cyclotron harmonics, where only the fast wave can penetrate to the plasma core. Most of the early tokamak experiments were in the lower hybrid frequency regime, and the observed electron interaction appeared to be very similar to that obtained with the slow wave at the same frequency. In particular, electron interaction with the fast wave was observed only below a density limit nearly the same as the well known slow wave density limit. In the more recent lower frequency fast wave experiments, electron interaction (heating and current drive) is observed at the center of the discharge, where slow waves are not present.

7824 (GA-A–21507) **Fuel ion rotation measurement and its implications on H-mode theories.** Kim, J. (General Atomics, San Diego, CA (United States)); Burrell, K.H.; Gohil, P.; Groebner, R.J.; Hinton, F.L.; Kim, Y.B.; Seraydarian, R.; Mandl, W.; Wade, M.R. General Atomics, San Diego, CA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. (CONF-9311147–2: IAEA meeting on H-mode physics, Naka (Japan), 15-17 Nov 1993). Order Number DE94004860. Source: OSTI; NTIS; INIS; GPO Dep.

Poloidal and toroidal rotation of the fuel ions (He^{2+}) and the impurity ions (C^{6+} and B^{5+}) in H-mode helium plasmas have been investigated in the DIII-D tokamak by means of charge exchange recombination spectroscopy, resulting in the discovery that the fuel ion poloidal rotation is in the ion diamagnetic drift direction while the impurity ion rotation is in the electron diamagnetic drift direction. The radial electric field obtained from radial force balance analysis of the measured pressure gradients and rotation velocities is shown to be the same regardless of which ion species is used and therefore is a more fundamental parameter than the rotation flows in studying H-mode phenomena. It is shown that the three contributions to the radial electric field (diamagnetic, poloidal rotation, and toroidal rotation terms) are comparable and consequently the poloidal flow does not solely represent the E x B flow. In the high-shear edge region, the density scale length is comparable to the ion poloidal gyroradius, and thus neoclassical theory is not valid there. In view of this new discovery that the fuel and impurity ions rotate in opposite sense, L-H transition theories based on the poloidal rotation may require improvement.

7825 (INP-MSU–92-34-283) **Laser-induced breakdown in heavy water: search for nuclear fusion evidence.** Goryachev, B.I. (and others); Kuznetsova, G.P.; Popov, Yu.V. Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1992. 9p. (NIIYaF-MGU–92-34-283.). Order Number DE94611496. Source: OSTI; NTIS (US Sales Only); INIS.

An attempt to detect fast neutrons yield in process of a laser-induced breakdown in heavy water (D_2O) was made. Emission of the neutrons was not detected. The upper limit of possible neutrons yield is 5 neutrons per joule of absorbed energy. 8 refs.; 2 figs.

7826 (IPP–6/313) **Nonlinear instabilities relating to negative-energy modes.** Pfirsch, D. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany). Mar 1993. 26p. Order Number DE94734000. Source: OSTI; NTIS (US Sales Only); INIS.

The nonlinear instability of general linearly stable systems allowing linear negative-energy perturbations is investigated with the aid of a multiple time scale formalism. It is shown that the basic equations thus obtained imply resonance conditions and possess inherent symmetries which lead to the existence of similarity solutions of these equations. These solutions can be of an explosive type, oscillatory or static. It is demonstrated that at least some of the oscillatory and static solutions are normally linearly unstable. (orig.). 5 figs.

7827 (JET-R–93-04) **Application of dynamic response analysis to JET heat pulse data.** Griguoli, A. (Technische Univ. Eindhoven (Netherlands)); Sips, A.C.C. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1993. 18p. Order Number DE94611460. Source: OSTI; NTIS (US Sales Only); INIS.

The plasma dynamic response can be used to study transport processes in a tokamak plasma. A method has been developed for the application of dynamic response analysis to study perturbations away from the plasma equilibrium. In this report perturbations on the electron temperature following a sawtooth collapse in the center of the plasma are considered. The method has been used to find mathematical description of a series of heat pulses at the Joint European Torus project (JET). From the plasma dynamic response, the time constants which characterise the heat pulse are obtained. These time constants are compared to the transport coefficients found in previous analysis of the JET heat pulse data. Various methods are discussed for applying dynamic response analysis to JET heat pulse data. (author).

7828 (LRP–477/93) **An experimental study of the harmonics generated during Alfven wave heating in TCA.** Borg, G.C. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Lister, J.B.; Dalla Piazza, S.; Martin, Y. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1993. 20p. Order Number DE94611467. Source: OSTI; NTIS; INIS.

During plasma excitation by high power Alfven waves in TCA, signals at harmonics of the generator frequency are observed in the plasma scrape-off layer. In this paper we report experimental investigations of the sheath effect and the excitation efficiency and dispersion properties of these harmonics. The results indicate that the harmonics arise either directly or indirectly through the driven Alfven waves and not the sheath effect at the exciting antenna. The RF ion saturation current is observed a non-negligible peak amplitude in comparison to the time averaged ion saturation current and may provide evidence of non-linear evolution of the driven Alfven waves. (author) 8 figs., 8 refs.

7829 (LRP–479/93) **Time-resolved measurements of highly-polymerised negative ions in rf silane plasma deposition experiments.** Howling, A.A. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Sansonnens, L.; Dorier, J.L.; Hollenstein, C. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jul 1993. 47p. Order Number DE94611447. Source: OSTI; NTIS; INIS.

The time-resolved fluxes of negative polysilicon hydride ions from a power-modulated rf silane plasma have been measured by quadrupole mass spectrometry and modeled using a simple polymerisation scheme. Experiments were performed with plasma parameters suitable for high-quality amorphous silicon deposition. Polysilicon hydride anions diffuse from the plasma with low energy (approximately 0.5 eV) during the afterglow after the electron density has decayed and the sheath fields have collapsed. The mass-dependence of the temporal behavior of the anion loss flux demonstrates that the plasma composition is influenced by the modulation frequency. The negative species attain much higher masses than the positive or neutral species, and anions containing as many as sixteen silicon atoms have been observed, corresponding to the 500 amu limit of the mass spectrometer. This suggests that negative ions could be the precursors to particle formation. Ion-molecule and ion-ion reactions are discussed and a simple negative ion polymerisation scheme is proposed which qualitatively reproduces the experimental results. The model shows that the densities of high mass negative ions in the plasma are strongly reduced by modulation frequencies near 1 kHz. Each plasma period is then too short for the polymerisation chain to propagate to high masses before the elementary anions are lost in each subsequent afterglow period. This explains why modulation of the rf power can reduce particle contamination. We conclude that, for the case of silane rf plasmas, the initiation steps which ultimately lead to particle contamination proceed by negative ion polymerisation. (author) 15 figs., 72 refs.

7830 (LRP–480/93) **Active feedback stabilization of axisymmetric modes in highly elongated tokamak plasmas.** Ward, D.J. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Hofmann, F. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jul 1993. 36p. Order Number DE94611468. Source: OSTI; NTIS; INIS.

Active feedback stabilization of the vertical instability is studied for highly elongated tokamak plasmas ($1 \leq \kappa \leq 3$), and evaluated in particular for the TCV configuration. It is shown that the feedback can strongly affect the form of the eigenfunction for these highly elongated equilibria, and this can have detrimental effects on the ability of the feedback system to properly detect and stabilize the plasma. A calculation of the vertical displacement that uses poloidal flux measurements, poloidal magnetic field measurements, and corrections for the vessel eddy currents and active feedback currents was found to be effective even in the cases with the worst deformations of the eigenfunction. We also examine how these deformations affect differently shaped equilibria, and it is seen that the magnitude of the deformation of the eigenfunction is strongly function of the plasma elongation. (author) 15 figs., 13 refs.

7831 (LRP–481/93) **Stochastic plasma heating by electrostatic waves: a comparison between a particle-in-cell simulation and a laboratory experiment.** Fivaz, M. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Fasoli, A.; Appert, K.; Trans, T.M.; Tran, M.Q.; Skiff, F. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Aug 1993. 21p. Order Number DE94611489. Source: OSTI; NTIS; INIS.

Dynamical chaos is produced by the interaction between plasma particles and two electrostatic waves. Experiments performed in a linear magnetized plasma and a 1D particle-in-cell simulation agree qualitatively: above a threshold wave amplitude, ion stochastic diffusion and heating occur on a fast time scale. Self-consistency appears to limit the extent of the heating process. (author) 5 figs., 18 refs.

7832 (LRP–482/93) **Diagnostics of particle genesis and growth in RF silane plasmas by ion mass spectrometry and light scattering.** Hollenstein, C. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Dorier, J.L.; Dutta, J.; Howling, A.A. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Aug 1993. 26p. (CONF-9308202–: Formation, transport and consequences of particles in plasmas, Chateau de Bonas (France), 30 Aug - 3 sep 1993). Order Number DE94611448. Source: OSTI; NTIS; INIS.

NATO Advanced Research Workshop.

Experimental identification of the precursors and processes leading to particles is essential for understanding particulate contamination in deposition plasmas. We have investigated particle formation in rf plasmas using light scattering (elastic and inelastic) and quadrupole ion mass spectrometry as complementary plasma diagnostics. Negative ions reach high masses (at least 500 amu) and are the only elementary species with a residence time on the scale of the powder formation time. Furthermore, a negative ion polymerisation scheme shows that the densities of high mass anions are strongly diminished at kHz power modulation frequencies, where reduced powder production is also observed. We conclude that negative ions are the particle precursors and that initial clusters grow by negative ion polymerisation in silane plasmas. In situ light scattering techniques are described to self-consistently determine particle size, number density and refractive index. Novel, visible photoluminescence measurements from particles suspended in the plasma are also reported. These diagnostics demonstrate that particle evolution proceeds by an agglomeration phase and that the particle properties are different from the bulk material early in the particle development. (author) 9 figs., 45 refs.

7833 (LRP–484/93) **Mode competition and startup in cylindrical cavity gyrotrons using high-order operating modes.** Whaley, D.R. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Tran, M.Q.; Tran, T.M.; Antonsen, T.M. Jr. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Oct 1993. 38p. Order Number DE94611498. Source: OSTI; NTIS; INIS.

The problem of mode competition in cylindrical cavity gyrotrons is considered. The normalized variable equations are used to calculate the oscillation regions of possible operating modes in the energy-velocity-pitch-angle plane. The analysis is self-consistent and includes the effect of changing beam current, pitch angle, and energy during the startup phase. The time evolution of beam parameters during startup is computed for several types of startup methods and used to determine the oscillating cavity modes during startup. Depending on the type of startup chosen, the cavity can be made to oscillate in several modes or in a single chosen operating mode -even for high order modes where many other possible operating modes exist. Some startup methods are seen to be less favorable than others, allowing for oscillation of unwanted modes and some methods are seen to be more sensitive to small beam/cavity misalignment. The accessibility to the high-efficiency hard excitation region can also be determined and is seen to depend on the startup scenario. The method is general and can be applied to any operating mode with the mode competition analysis specifically useful for high order modes where the spectrum is dense. The analysis of the accessibility to the hard excitation region is applicable to high and low order operating modes. Both q=1 and q=2 longitudinal mode numbers are considered. (author) 14 figs., 12 refs.

7834 (LRP–485/93) **A 3-D Fokker-Planck code for studying parallel transport in tokamak geometry with arbitrary collisionalities and application to neoclassical resistivity.** Sauter, O. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Harvey, R.W.; Hinton, F.L. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Oct 1993. 8p. Order Number DE94611461. Source: OSTI; NTIS; INIS.

A new 3-D Fokker-Planck code, CQL, which solves the Fokker-Planck equations with two velocity coordinates and one spatial coordinate parallel to the magnetic field lines B/B, has been developed. This code enables us to model the parallel transport for low, intermediate and high collisional regime. The physical model, the possible relevant applications of the code as well as a first application, the computation of the neoclassical resistivity for various collisionalities and aspect ratios in tokamak geometry are presented. (author) 3 figs., 3 refs.

7835 (ORNL/FTR–4785) **Travel to Austria and the Netherlands to attend the 12th Meeting of the Atomic and Molecular Data Centers and ALADDIN Network: Foreign trip report, September 18–29, 1993.** Havener, C.C. Oak Ridge National Lab., TN (United States). 14 Oct 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94002185. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The 12th Meeting of the Atomic and Molecular Data Centers and ALADDIN Network allowed each represented data center to present technical aspects and current projects in order to improve the efficiency of data exchange among the centers. The second IAEA meeting was concerned with assessing the current data situation for collision processes involving medium- and high-Z plasma impurities, particularly in view of International Thermonuclear Experimental Reactor (ITER) design needs. The laboratory visit to Utrecht provided an in-depth and up-to-date assessment of the ion-atom ionization experiment and allowed discussions concerning future experimental effort at ORNL.

7836 (ORNL/FTR–4843) **Travel to Germany to attend the International Thermonuclear Experimental Reactor (ITER) RF Technical Meeting: Foreign trip report, October 19–27, 1993.** Swain, D.W.; Hoffman, D.J. Oak Ridge National Lab., TN (United States). 24 Nov 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94003791. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The International Thermonuclear Experimental Reactor (ITER) Joint Central Team (JCT) held an RF Technical Meeting at the Co-Center at Garching, Germany, from October 21–26, 1993, with participants from the JCT and the four parties. The meeting covered the design and R&D for the ITER electron cyclotron (ECH) and ion cyclotron (ICH) systems. Primary conclusions of the meeting were: Either ECH or ICH could heat ITER to ignition. If Rebut-Lallia-Watkins scaling is correct, 50 MW of power would be adequate; if achieving H-mode is required for ignition, 100–200 MW might be required to exceed the H-mode threshold. The primary R&D needed to achieve an ECH system is development of a 1 MW, steady-state gyrotron microwave source at 160 GHz with a reliable vacuum window. For ICH, sources are commercially available; primary R&D needed is development and testing of a reliable Faraday shield design. RF systems should be designed to do current drive "experiments." Steady-state current-driven operation at full design plasma current (25 MA) is not required; however, steady-state operation at reduced plasma parameters should be achievable with the initial heating and current drive system.

7837 (ORNL/FTR–4849) **Travel to Japan for the Fourth IAEA Technical Committee meeting on H-mode physics: Foreign trip report, October 12–19, 1993.** Hillis, D.L.; Carreras, B.A. Oak Ridge National Lab., TN (United States). 19 Dec 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004871. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The purpose of this trip was to participate in the Fourth IAEA Technical Committee Meeting on H-mode Physics. The travelers presented papers on "Dynamics of L to H Bifurcation" (B.A. Carreras) and "Helium Transport and Exhaust studies of H-mode discharges in the DIII-D Tokamak" (D.L. Hillis). The workshop highlighted the recent H-mode studies of the major international tokamak programs: ASDEX, DIII-D, JET, JT-60U, JFT-2M and the recent H-mode studies on the W-VIIAS and CHS stellarators. Following the workshop, an additional day was spent discussing upcoming experiments on JT-60U and possible areas for future collaboration and modeling.

7838 (PPPL–2948) **ICRF heating of TFTR deuterium supershot plasmas in the ^{3}He minority regime.** Taylor, G. (Princeton Univ., NJ (United States). Plasma Physics Lab.); Wilson, J.R.; Goldfinger, R.C. Princeton Univ., NJ (United States). Plasma Physics Lab. Jan 1994. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03073. Order Number DE94005545. Source: OSTI; NTIS; INIS; GPO Dep.

The increased core electron temperature produced by ICRF heating of TFTR, D-T neutral-beam-heated supershot plasmas is expected to extend the alpha particle slowing down time and hence enhance the central alpha particle pressure. In preparation for the TFTR D-T operational phase, which is due to start in late 1993, a series of experiments were conducted on TFTR to explore the effect of ICRF heating on the performance and stability of low recycling, deuterium supershot plasmas in the ^{3}He minority heating regime. The coupling of up to 7.4 MW of 47 MHz ICRF power to full size ^{3}He minority, deuterium supershots heated with up to 30 MW of deuterium neutral beam injection has resulted in a significant increase in core electron temperature. Simulations of equivalent D-T supershots predict that such ICRF heating should result in approximately a 60% increase in the alpha particle slowing down time and an enhancement of about 30% in the central alpha pressure. Future experiments to be conducted at ICRF powers up to 12.5MW during the upcoming TFTR D-T campaign may result in even greater enhancements in core alpha parameters. This paper presents results from experiments performed at an axial toroidal magnetic field of ~4.8T, where the minority resonance was within 0.1–0.15 m of the plasma core. Combined ICRF and neutral beam heating powers in these experiments reached TFTR record levels of over 37 MW, which allowed an exploration of the power loading limits on the carbon limiter tiles. The plasma current was operated at 1.85 and 2.2 MA and sawtooth suppression was observed at the higher plasma current.

7839 (PPPL–2951) **Cyclotron subharmonics resonant (CSR) heating.** Abe, H. Princeton Univ., NJ (United States). Plasma Physics Lab. Jan 1994. 73p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03073. Order Number DE94005541. Source: OSTI; NTIS; INIS; GPO Dep.

The cyclotron subharmonics resonant (CSR) heating mechanism is studied using particle simulation codes with an emphasis on the relationship between CSR and the nonlinear Landua damping.

7840 (PPPL–2952) **Experimental study of magnetic reconnection during a sawtooth crash in a high temperature tokamak plasma.** Yamada, M. (Princeton Univ., NJ (United States). Plasma Physics Lab.); Manickam, J.; Pomphrey, N.; Levinton, F.M.; Nagayama, Y. Princeton Univ., NJ (United States). Plasma Physics Lab. Jan 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03073. Order Number DE94005537. Source: OSTI; NTIS; INIS; GPO Dep.

Magnetic reconnection is investigated in high temperature TFTR tokamak plasmas by a set of non-perturbative diagnostics. During the crash phase of sawtooth oscillations in the plasma discharges, the ECE (electron cyclotron emission) diagnostic measures a fast flattening of the 2-D electron temperature profile in a poloidal plane, an observation consistent with the Kadomtsev reconnection theory. On the other hand motional Stark effect(MSE) measurements indicate that central q values do not relax to unity after the crash, but increase only by 5-10%, typically from 0.7 to 0.75. The latter result is in contradiction with the models of Kadomtsev and/or Wesson. A heuristic model for the magnetic reconnection at the sawtooth crash is also presented.

7841 (PPPL–2953) **The theory of stabilization of sawtooth oscillations in TFTR supershots.** Zakharov, L. (Princeton Univ., NJ (United States). Plasma Physics Lab.); Levinton, F.; Migliuolo, S.; Rogers, B. Princeton Univ., NJ (United States). Plasma Physics

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Lab. Nov 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03073. Order Number DE94005539. Source: OSTI; NTIS; INIS; GPO Dep.

A theoretical concept of onset and stabilization of sawtooth oscillations in tokamaks is formulated based on the analysis of supershots in the Tokamak Fusion Test Reactor (TFTR). While the linear theory, which includes the ideal m = 1 mode, contradicts the experimental data, the criterion of ω^*-stabilization of the collisionless m = 1 reconnection mode determines an operational space for the sawtooth-free phase in TFTR.

7842 (PPPL–2956) **Poloidal flux linkage requirements for the International Thermonuclear Experimental Reactor.** Jardin, S.C.; Kessel, C.; Pomphrey, N. Princeton Univ., NJ (United States). Plasma Physics Lab. Jan 1994. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03073. Order Number DE94005538. Source: OSTI; NTIS; INIS; GPO Dep.

We have applied two computational models to calculate the poloidal flux linkage requirements for the current ramp-up and for the flattop phase of the proposed International Thermonuclear Experimental Reactor (ITER). For the current ramp-up phase, we have used the TSC code to simulate the entire current ramp-up period as described in the TAC-3 Physics Report. We have extended the time of the simulation to cover the full current penetration time, that is, until the loop voltage is a constant throughout the plasma. Sensitivity studies have been performed with respect to current ramp-up time, impurity concentration, and to the time of onset of auxiliary heating. We have also used a steady state plasma equilibrium code that has the constant loop voltage constraint built in to survey the dependence of the steady state loop-voltage on the density and temperature profiles. This calculation takes into account the plasma bootstrap current contribution, including noncircular and collisional corrections. The results can be displayed as contours of the loop-voltage on a POPCON like diagram.

7843 (UCRL-ID–115497) **O-shell emission of uranium in a high temperature, low density plasma.** Fournier, K.B. (Lawrence Livermore National Lab., CA (United States)); Osterheld, A.L.; Goldstein, W.H.; Finkenthal, M.; Holmes, C.P.; Moos, H.W. Lawrence Livermore National Lab., CA (United States). Dec 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004281. Source: OSTI; NTIS; INIS; GPO Dep.

We present models for the soft X ray emission spectra of UXXIV, UXXV, UXXX, UXXXI and UXXXII under tokamak conditions. The spectra are calculated from collisional-radiative models and cover the 60 to 200Å range. A fully relativistic parametric potential code has been used for the ab initio atomic structure calculations, and electron impact excitation rates have been computed in the distorted wave approximation. The ions considered here display a range of spectroscopic phenomena to be found in the O-shell of heavy elements, that can be compared with experimental observations. These include the configuration interaction between $5s^25p^65d^{k-1}5f$ and $5s^25p^55d^{k+1}$ in ions with $5s^25p^65d^k$ ground configurations, represented by UXXIV (k=l), configuration interaction between $5s^25p^{k-1}5d$ and $5s^25p^{k+1}$ in ions with $5s^25p^k$ ground configurations, such as UXXX (k=l); the unique system of satellite emission lines to the resonant 5s-5p transitions in UXXXII arising from highly metastable $4f^{13}5s^2$ levels; and the bright, isolated resonant lines associated with the closed shell UXXXI and systems.

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Refer also to citation(s) 6991, 6994, 7425, 7815, 7319, 7836, 7340

7844 (ANL/EP/CP–79903) **Design windows for a He cooled fusion reactor.** Sze, Dai-Kai; Hassanein, A. Argonne National Lab., IL (United States). Oct 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931018–72: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94004626. Source: OSTI; NTIS; INIS; GPO Dep.

A design window concept is developed for a He-cooled fusion reactor blanket and divertor design. This concept allows study of a parameter regime under which a possible design exists with different design requirements, such as allowable pumping fraction. The concept identifies not only the required parameter regime, but also investigates the robustness of the design, i.e., the validity of the design with change of design parameters and requirements. Some recent directions of helium cooled design for ITER and for divertor can also be explained by this design window concept.

7845 (ANL/EP/CP–79904) **Liquid metal MHD and heat transfer in a tokamak blanket slotted coolant channel.** Reed, C.B. (Argonne National Lab., Chicago, IL (United States)); Hua, T.Q.; Black, D.B.; Kirillov, I.R.; Sidorenkov, S.I.; Shapiro, A.M.; Evtushenko, I.A. Argonne National Lab., IL (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-931018–73: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94004622. Source: OSTI; NTIS; INIS; GPO Dep.

A liquid metal MHD (Magnetohydrodynamic)/heat transfer test was conducted at the ALEX (Argonne Liquid Metal Experiment) facility of ANL (Argonne National Laboratory), jointly between ANL and NIIEFA (Efremov Institute). The test section was a rectangular slotted channel geometry (meaning the channel has a high aspect ratio, in this case 10:1, and the long side is parallel to the applied magnetic field). Isothermal and heat transfer data were collected. A heat flux of ~9 W/cm^2 was applied to the top horizontal surface (the long side) of the test section. Hartmann Numbers to 1050 (2 Tesla), interaction parameters to 9×10^3, Peclet numbers of 10–200, based on the half-width of the small dimension (7mm), and velocities of 1–75 cm/sec. were achieved. The working fluid was NaK (sodium potassium eutectic). All four interior walls were bare, 300-series stainless steel, conducting walls.

7846 (ANL/FPP/TM–268) **Modelling erosion damage from low-energy plasma gun simulations of disruptions.** Ehst, D.A.; Hassanein, A. Argonne National Lab., IL (United States). Oct 1993. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94005196. Source: OSTI; NTIS; INIS; GPO Dep.

Energy transfer to material surfaces is dominated by photon radiation through low temperature plasma vapors if tokamak disruptions are due to low kinetic energy particles ($\lesssim$ 100 eV). Simple models of radiation transport are derived and incorporated into a fast-running computer routine to model this process. The results of simulations are in good agreement with plasma gun erosion tests on several metal targets.

7847 (CONF-931018–43) **High-speed repetitive pellet injector for plasma fueling of magnetic confinement fusion devices.** Combs, S.K. (and others); Baylor, L.R.; Foust, C.R. Oak Ridge National Lab., TN (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Symposium on fusion engineering; Hyannis, MA (United States); 11-15 Oct 1993. Order Number DE94002792. Source: OSTI; NTIS; INIS; GPO Dep.

The projected fueling requirements of future magnetic confinement devices for controlled thermonuclear research [e.g., the International Thermonuclear Experimental Reactor (ITER)] indicate that a flexible plasma fueling capability is required. This includes a mix of traditional gas puffing and low- and high-velocity deuterium-tritium pellets. Conventional pellet injectors (based on light gas guns or centrifugal accelerators) can reliably provide frozen hydrogen pellets (1- to 6-mm-diam sizes tested) up to ~1.3-km/s velocity at the appropriate pellet fueling rates (1 to 10 Hz or greater). For long-pulse operation in a higher velocity regime (>2 km/s), an experiment in collaboration between Oak Ridge National Laboratory (ORNL) and ENEA Frascati is under way. This activity will be carried out in the framework of a collaborative agreement between the US Department of Energy and European Atomic Energy Community – ENEA Association. In this experiment, an existing ORNL hydrogen extruder (equipped with a pellet chambering mechanism/gun barrel assembly) and a Frascati two-stage light gas gun driver have been combined on a test facility at ORNL. Initial testing has been carried out with single deuterium pellets accelerated up to 2.05 km/s with the two-stage driver; in addition, some preliminary repetitive testing (to commission the diagnostics) was performed at reduced speeds, including sequences at 0.5 to 1 Hz and 10 to 30

pellets. The primary objective of this study is to demonstrate repetitive operation (up to ~1 Hz) with speeds in the 2- to 3-km/s range. In addition, the strength of extruded hydrogen ice as opposed to that produced in situ by direct condensation in pipe guns can be investigated. The equipment and initial experimental results are described.

7848 (CONF-931018–64) **Rf modeling and design of a folded waveguide launcher for the Alcator C-Mod tokamak.** Bigelow, T.S. (Oak Ridge National Lab., TN (United States)); Fogelman, C.F.; Baity, F.W.; Carter, M.D.; Hoffman, D.J.; Ryan, P.M.; Yugo, J.J.; Golovato, S.N.; Bonoli, P. Oak Ridge National Lab., TN (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Symposium on fusion engineering; Hyannis, MA (United States); 11-15 Oct 1993. Order Number DE94003588. Source: OSTI; NTIS; INIS; GPO Dep.

The folded waveguide (FWG) launcher is being investigated as an improved antenna configuration for plasma heating in the ion cyclotron range of frequencies (ICRF). A development FWG launcher was successfully tested at Oak Ridge National Laboratory (ORNL) with a low-density plasma load and found to have significantly greater power density capability than current strap-type antennas operating in similar plasmas. To further test the concept on a high density tokamak plasma, a collaboration has been set up between ORNL and Massachusetts Institute of Technology (MIT) to develop and test an 80-MHz, 2-MW FWG on the Alcator C-Mod tokamak at MIT. The radio frequency (rf) electromagnetic modeling techniques and laboratory measurements used in the design of this antenna are described in this paper. A companion paper describes the mechanical design of the FWG.

7849 (CONF-931018–65) **Design of folded waveguide antenna for Alcator C-Mod.** Fogelman, C.H. (Oak Ridge National Lab., TN (United States)); Bigelow, T.S.; Carter, M.D.; Hoffman, D.J.; Riemer, B.W.; Yugo, J.J.; Golovato, S.N.; Bonoli, P. Oak Ridge National Lab., TN (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Symposium on fusion engineering; Hyannis, MA (United States); 11-15 Oct 1993. Order Number DE94003584. Source: OSTI; NTIS; INIS; GPO Dep.

The Oak Ridge National Laboratory (ORNL) ion cyclotron range of frequencies (ICRF) antenna for Alcator C-Mod is a folded waveguide (FWG) antenna designed to determine whether the FWG can serve as a high power density, ceramic-free antenna for both present heating and fast wave current drive (FWCD) applications and for future tokamaks such as the International Thermonuclear Experimental Reactor (ITER) and the Tokamak Physics Experiment (TPX). The FWG is particularly attractive because it has a low internal electric field per unit power coupled to the Plasma. This results in more power capability and has been demonstrated by 1-MW (unloaded) tests on the Radio Frequency Test Facility (RFTF). The experiment will characterize the impact of an FWG on impurity control in the presence of high power density and on central heating. The antenna is designed to withstand the tokamak environment, including high heat fluxes, high-temperature bakeout, and major disruptions, without vacuum leaks. The front face is curved to fit the plasma outline. Two front plates are fabricated for the antenna one with full-width slits at every other location between vanes and the other with alternating right and left half-width slits at every location between vanes for pi-phasing.

7850 (CONF-931018–74) **Argon frost continuous cryopump for fusion applications.** Foster, C.A.; McCurdy, H.C. Cryogenic Applications F, Inc., Clinton, TN (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-91ER81236. From Symposium on fusion engineering; Hyannis, MA (United States); 11-15 Oct 1993. Order Number DE94004478. Source: OSTI; NTIS; INIS; GPO Dep.

A cryopumping system based on the snail continuous cryopump concept is being developed for fusion applications under a DOE SBIR grant. The primary pump is a liquid helium cooled compound pump designed to continuously pump and fractionate deuterium/tritium and helium. The D/T pumping stage is a 500 mm bore cryocondensation pump with a nominal pumping speed of 45,000 L/s. It will be continuously regenerated by a snail regeneration by head every 12 minutes. Continuous regeneration will dramatically reduce the vulnerable tritium inventory in a fusion reactor. Operating at an inlet pressure of 1 millitorr, eight of these pumps could pump the projected D/T flow in the ITER CDA design while reducing the inventory of tritium in the pumping system from 630 to 43 grams. The helium fraction will be pumped in a compound argon frost stage. This stage will also operate continuously with a snail regeneration head. In addition the argon spray head will be enclosed inside the snail, thereby removing gaseous argon from the process chamber. Since the cryocondensation stage will intercept over 90% of the D/T/H steam, a purified stream from this stage could be directly reinjected into the plasma as gas or pellets, thereby bypassing the isotope separation system and further simplifying the fuel cycle. Experiments were undertaken in Phase I which demonstrated continuous cryosorption pumping of hydrogen on CO_2 and argon frosts. The pumping system and its relevance to fusion reactor pumping will be discussed.

7851 (DOE/ER/10388–T1) **Helium production cross sections for fusion-energy neutrons: Final report, [March 1, 1979–December 31, 1986].** Kneff, D.W. Rockwell International Corp., Canoga Park, CA (United States). Rocketdyne Div. Mar 1987. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AT03-79ER10388. Order Number DE94003920. Source: OSTI; NTIS; INIS; GPO Dep.

Cross section measurements Completed under this program include 25 pure elements and 33 separated isotopes at a neutron energy of ~14.8 MeV. These measurements provide a large helium generation data base for fusion reactor materials applications that was not previously available, and satisfies most of the (n,xα) cross section requests to the DOE Nuclear Data Committee at this energy. They also provide a strong data base for nuclear model validation. The measured cross sections are in good agreement with other published measurements in most cases where comparisons are available. Additional measurements were initiated at RTNS-II to extend this data base to other materials of importance for fusion reactor applications. This program also included the development of a constant temperature furnace to extend our measurement capabilities to lower helium concentrations. The use of this furnace was demonstrated successfully, and its application included the measurement of several small cross sections reported here for 14.8-MeV neutrons. The constant temperature furnace was developed for measurements at lower neutron energies, and its successful provided an enhanced capability to proceed with those operation measurements.

7852 (DOE/ER/51124–13) **Ideal pre-conceptual design development.** Gentzlinger, R. (Grumman Corp., Princeton, NJ (United States)); Mendelsohn, S.; Abel, B. Grumman Corp., Princeton, NJ (United States); Princeton Univ., NJ (United States). Plasma Physics Lab. [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER51124 ; AC02-76CH03073. (CONF-931018–76: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94004965. Source: OSTI; NTIS; INIS; GPO Dep.

A preconceptual design has been produced for a plasma device to further divertor concepts and validate technology in support of the International Thermonuclear Experimental Reactor program. The ITER Diverter Experiment and Laboratory (IDEAL) design effort is to develop a reliable, maintainable and robust facility for steady-state divertor simulation experiments. The configuration includes a 30 meter vacuum vessel, enclosed within a set of 30 high field superconducting solenoid modules, a resistive quadrupole coil set, a radio-frequency heating system and a complement of diagnostics. It is planned to utilize existing facilities, and off-the-shelf hardware, wherever possible to maximize technological return on investment.

7853 (DOE/ER/52111–6) **Application of railgun principle to high-velocity hydrogen pellet injection for magnetic fusion reactor fueling: Progress report, October 1, 1992–September 30, 1993.** Kim, Kyekyoon; Zhang, Jianhua. Illinois Univ., Urbana, IL (United States). Fusion Technology Lab. [1993]. 85p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-84ER52111. Order Number DE94004411. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses research being conducted on hydrogen pellet acceleration by railgun accelerators for fueling magnetic fusion reactors.

7854 (DOE/ER/52158–11) **Fusion reactor systems studies: Progress report, November 1, 1992–October 31, 1993.** Wisconsin Univ., Madison, WI (United States). Fusion Technology Inst. 9 Sep 1993. 142p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-89ER52158. Order Number DE94003162. Source: OSTI; NTIS; INIS; GPO Dep.

Fusion Technology Institute personnel actively participated in the ARIES/PULSAR project during the present contract period. Numerous presentations were made at PULSAR project meetings, major contributions were written for the ARIES-II/IV Final Report presentations and papers were given at technical conferences contributions were written for the ARIES Lessons Learned report and a very large number of electronic-mail and regular-mail communications were sent. The remaining sections of this progress report win summarize the work accomplished and in progress for the PULSAR project during the contract period. The main areas of effort are: PULSAR Research; ARIES-II/IV Report Contributions; ARIES Lessons Learned Report Contributions; and Stellarator Study.

7855 (DOE/FTR–93018044) **Travel to France, Germany and the United Kingdom to participate in fusion technology program reviews and planning meetings: Foreign trip report, October 26–November 6, 1991.** McGrath, R.T. Sandia National Labs., Albuquerque, NM (United States). 11 Nov 1991. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93018044. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Fusion technology program reviews and planning meetings. The status of projects in progress was reported and program goals for FY92 defined. On Monday and Tuesday, 28–29 October 1991, a Program Review for the US-EC Bilateral Implementing Agreement on Tore Supra was held in Cadarache. Topics covered included exchanges on the pellet injector, the RF antennas, the pump limiter and a proposed new exchange on high beta poloidal experiments and analysis of confinement on Tore Supra. On Wednesday, October 30, 1991, I attended the Overview Presentations covering the US/KFA Bilateral Agreement on TEXTOR. Some recent results from TEXTOR were reported. A status report and recent results from the ALT-II pump limiter program was reported. Plans and schedule for the upgrade of TEXTOR were presented. On Monday and Tuesday, November 4–5, 1991, I visited JET. I was hosted by M. Pick and E. Deksnis. We discussed (1) the current divertor performance on JET, (2) design and high heat flux testing of the Mark I inertially cooled beryllium block divertor and the Mark II actively cooled Be brazed divertor and (3) the experiments taking place during that week on JET using tritium neutral beams.

7856 (DOE/FTR–93018123) **Travel to Osaka, Japan for the International Atomic Energy Agency Technical Committee Meeting on drivers for inertial confinement fusion in Osaka, Japan: Foreign trip report, April 13–21, 1991.** Quintenz, J.P. Sandia National Labs., Albuquerque, NM (United States). 23 Apr 1991. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93018123. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This was the first meeting of the Technical Committee on Drivers for Inertial Confinement Fusion (ICF) to be held since 1983. Many speakers commented on the need to have more meetings of this group to speed the advance of our understanding by improving communications between the various scientists working in the field. A strong correlation was drawn between the magnetic fusion energy (MFE) community's open scientific exchange and rapid advances made. The point made was that ICF could benefit from a similar atmosphere of open exchange. Marshall Sluyter called this the "decade of the upgrades" with most major facilities either in the process of upgrading or with designs for such upgrades. He also said that there was an air of expectancy in the US ICF community. Many talks were devoted to plans and expectations for the upgraded facilities. It was very clear from the discussions I had with many participants that budgets are a problem world wide in the ICF community. New facilities may be delayed and progress will be slowed by these budget problems. The atmosphere, however, was still hopeful and positive.

7857 (DOE/FTR–93018257) **Participation in the Second International Symposium on Fusion Nuclear Technology: Foreign trip report, May 31–June 12, 1991.** Herring, J.S. EG and G Idaho, Inc., Idaho Falls, ID (United States). 5 Aug 1991. 55p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE93018257. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The primary purpose for this trip was to attend the Second International Symposium on Fusion Nuclear Technology (ISFNT-2) and there to present an invited paper which reviewed recent work on fusion reactor safety. In addition, meetings were held at the Institut fuer Technische Physik (ITP) of the Kernforschungszentrum Karlsruhe (KfK) to discuss future plans for analyses and experiments in superconducting magnet safety and at the Institut fuer Neutronenphysik und Reaktortechnik (INR) of KfK to discuss the transfer of the UFOTRI code to the Fusion Safety Program. As originally planned, this trip was to last until June 22 and was to include chairing an IEA workshop on future directions in superconducting magnet safety research and attendance of a workshop on superconducting magnet energy storage, both at KfK. However, because the magnet designers from NET were not willing at this time to take part in the workshop, we decided to delay the workshop for about 6 months.

7858 (DOE/FTR–93018326) **Travel to Japan for meeting on drivers for Inertial Confinement Fusion: Foreign trip report, April 13–21, 1991.** Ramirez, J.J. Sandia National Labs., Albuquerque, NM (United States). [1991]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93018326. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The primary purpose of this trip was to present a technical paper at the IAEA Technical Committee Meeting on Drivers for Inertial Confinement Fusion held April 13–21, 1991 in Osaka, Japan. The paper 1 presented was entitled "Intense Light-Ion Beams Provide A Robust, Common Driver Path Towards Ignition, Gain and Commercial Fusion Energy." The talk describes the path we are pursuing at Sandia in developing intense ion beams as a viable ICF driver. There was much interest expressed in understanding our approach towards ignition in an upgraded facility at Sandia, our design for a high-gain Laboratory Microfusion Facility, and the LIBRA concept for a commercial fusion reactor. In general, the conference provided me with a very good overview on the scope and status of the various national research efforts on ICF drivers. I also made personal contacts with various research scientists in Japan that could result in significant benefit to the US light-ion beam driver development program. A key interest is the work of S. Miyamoto, et al. on two-stage ion diode experiments at the Institute of laser Engineering (ILE) using an inductive voltage adder accelerator. They reported efficient diode operation, performance consistent with the theory of these diode published by Slutz and Desjarlais (SNL), and a factor of two reduction in the beam divergence in the two-stage geometry vs that observed in the single-stage configuration. We started a low-level experimental effort on 2-stage diodes at Sandia earlier this year. Multi-stage acceleration offers significant potential advantages for future ICF drivers.

7859 (DOE/FTR–93018328) **Travel to Europe concerning beryllium plasma spray research: Foreign trip report, June 1–9, 1991.** Smith, M.F. Sandia National Labs., Albuquerque, NM (United States). 25 Jun 1991. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93018328. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Mark Smith met with members of the First Wall Component Development Group at the Joint European Torus (JET) in Culham, England. These meetings focused on past and proposed research and development at Sandia National Laboratories and Los Alamos National Laboratory concerning plasma sprayed beryllium coatings for first wall and other high heat flux applications in magnetic confinement fusion energy devices. The JET representatives expressed considerable interest in this work, and these discussions may lead to JET supported projects in this area at Sandia and/or

Los Alamos. Dr. Michael Pick, Leader of the JET First Wall Components Group, will visit Sandia and perhaps Los Alamos in August,1991, for follow-up discussions on potential joint beryllium research. Dr. Smith also presented a paper entitled, "Plasma Sprayed Materials for Magnetic Fusion Energy Devices," at the 2nd Plasma Technik Symposium in Lucerne, Switzerland. This paper was well received and generated significant interest among conference participants. During the conference. Mark Smith also obtained interesting new information regarding some developments in plasma spray technology in Europe. He also toured the manufacturing plant of the major European supplier of vacuum plasma spray equipment.

7860 (DOE/FTR–93018329) **Travel to Berlin, Germany for conference on Controlled Fusion and Plasma Physics: Foreign trip report, June 1–8, 1991.** Snipes, J.A. Massachusetts Inst. of Tech., Cambridge, MA (United States). Plasma Fusion Center. 25 Jun 1991. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER54084. Order Number DE93018329. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Dr. J.A. Snipes, a staff member at the MIT Plasma Fusion Center, attended the 18th European Physical Society Conference on Controlled Fusion and Plasma Physics held in Berlin, Germany from 3–7 June 1991. The conference included results from laboratories throughout the world such as JET, ASDEX, JT60 and JT60-U, TEXTOR, TFTR, DIII-D, TEXT, ATF, PBX, FTU, Tore Supra, T-10 and T-15, COMPASS, and the ZIE, Berlin. The purpose of the trip was to present results of "Wall Conditioning by Lithium Pellet Injection on TFTR" that has been accomplished over the past year through an arrangement between the MIT Plasma Fusion Center and Princeton Plasma Physics Laboratory, funded by DOE Grant No. FG02-90ER54084, "Impurity Pellet Experiment at TFTR."

7861 (DOE/FTR–93018607) **Travel to Germany for ITER task negotiations: Foreign trip report, July 11–17, 1993.** Wilson, K.L. Sandia National Labs., Livermore, CA (United States). 28 Jul 1993. 144p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DR00789. Order Number DE93018607. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The purpose of this meeting was to give feedback on the draft Request for Proposals that had been issued by the Garching JCT Co-Center. In the areas of (1) First Wall/Blanket/Shield, (2) Divertor Plasma Interface, and (3) Plasma Heating and Diagnostics. Also, the meeting was supposed to clarify the activities to be carried out for credit under the CY1993 Emergency Task Agreement. Representatives of the Home Teams from the US, EC, and Japan were present the meeting. Unfortunately, the Russian Federation was unable to send any representatives to the meeting. Instead, their positions were communicated by faxed reports.

7862 (DOE/FTR–93018761) **Travel to Japan to attend the US-Japan RF Heating Technology Workshop: Foreign trip report, February 24–March 9, 1991.** Takase, Yuichi. Massachusetts Inst. of Tech., Cambridge, MA (United States). Plasma Fusion Center. 4 Apr 1991. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-78ET51013. Order Number DE93018761. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This trip report was prepared by Yuichi Takase, Research Scientist at the MIT Plasma Fusion Center. The purpose of the trip was to attend the US-Japan RF Heating Technology Workshop Naka, Ibaraki-ken, Japan. More detailed information on ICRF antenna design and other aspects of ICRF heating, which is not obtainable through workshop presentations alone, were obtained from subsequent visits to JAERI, Toshiba (Yokohama) and National Institute for Fusion Science (Nagoya). Construction of JT-60U has been completed and coil tests are under progress. They will start operation by the end of March. There is significant upgrade in the ICRF heating system with two large antennas and a planned power upgrade to 9.5 MW with the replacement of final amplifier tubes to X2274. There is also significant upgrade in the NBI capability, including a plan for 500 kV negative NBI in 1994. ECH is also scheduled for 1994, and they have started a significant R&D effort in this area, including gyrotron development in collaboration with Toshiba. National Institute for Fusion Science (NIFS) has started construction of the Large Helical Device, which is scheduled to start operating in 1997. There will be significant rf program in both ECH and ICRF with about 10 MW each, in addition to 20 MW of NBI. There are smaller-scale experiments on JFT-2M, JIPPT- IIU, WT-3, and TRIAM-IM tokamaks.

7863 (DOE/FTR–93018765) **Participation in the IEA workshop on low activation materials: Foreign trip report, April 8–12, 1991.** Piet, S.J. EG and G Idaho, Inc., Idaho Falls, ID (United States). 23 Apr 1991. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE93018765. Source: OSTI; NTIS (US Sales Only); GPO Dep.

With six other Americans I participated in the IEA Workshop on Low Activation Materials (LAMs) hosted by Culham Labs in the United Kingdom on April 8–12, 1991. The body of this trip report describes the objectives, major results and conclusions, and major recommendations as I see them. The other Americans at the meeting are more knowledgeable than I with regard to material science and neutronics/activation calculations. Thus, I focus my trip report on safety and environmental criteria and ramifications. In summary, this meeting was one of the most productive of any international meeting I've ever attended. We made great progress in forming a consensus on defining LAMs. I want to commend the head of the US delegation, Bill Wiffen, and our Culham hosts for their highly successful efforts to organize and plan this meeting. This meeting has moved the fusion community another step closer to LAMs in commercial fusion power plants. Naturally, there are future steps to take, which are the subject of my recommendations listed later.

7864 (DOE/FTR–93019137) **Travel to Germany to discuss European licensing of potential ITER design options: Foreign trip report, July 10–17, 1993.** Petti, D.A. EG and G Idaho, Inc., Idaho Falls, ID (United States). 4 Aug 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE93019137. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report discusses European licensing of potential ITER design options.

7865 (DOE/FTR–93019285) **Participation in the US-Japan workshop on physics issues for steady state tokamaks: Foreign trip report, June 27–July 3, 1993.** Bonoli, P.T. Massachusetts Inst. of Tech., Cambridge, MA (United States). Plasma Fusion Center. 18 Aug 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-78ET51013. Order Number DE93019285. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This trip report summarizes the main points and conclusions of a US-Japan Workshop on Physics Issues for Safety State Tokamaks. The important elements for steady state reactor operation are reviewed and the successful demonstration of these key elements in existing and future experiments is discussed.

7866 (DOE/FTR–94001285) **Travel to France to discuss with the Tore Supra staff the repair and reinstallation of the Phase III Outboard Limiter: Foreign trip report, September 19–25, 1993.** Nygren, R.E. Sandia National Labs., Albuquerque, NM (United States). 29 Sep 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE94001285. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This trip covered the time at Tore Supra when repairs on the Phase III Outboard Limiter are nearing completion and the schedule for reinstallation of the limiter is being discussed. The trip coincided with the Specialists' Workshop on High Heat Flux Component Cooling hosted by Cadarache under the auspices of CEA (Commisariat a L'Energie Atomique) - Euratom. The schedule for the reinsertion of the Phase III Outboard Limiter could be as early as late October. However, it appears that the desire to continue the physics program without interruptions may delay this reinsertion. The Workshop, an informal annual meeting of experts in thermal-hydraulics applied to fusion, was excellent. The group noted significant (much needed) additions to experimental data on samples with one-sided heating. A new model by Celata (ENEA, Italy) for Critical Heat Flux, which combined several physically based models, showed excellent agreement with the data base, an advance all the more

impressive because of its lack of any empirical constants. A correlation by Yin (AECL, Canada) of subcooled boiling over the parameter range of interest in fusion showed much better agreement with selected data than the often used Thom's correlation.

7867 (DOE/FTR–94001875) **Travel to England for conference on gyrotron and high power microwave research: Foreign trip report, September 4–11, 1993.** Kreischer, K.; Temkin, R. Massachusetts Inst. of Tech., Cambridge, MA (United States). Plasma Fusion Center. 28 Oct 1993. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC02-93ER54186. Order Number DE94001875. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The primary purpose of the trip was to attend the conference in England, where recent progress in gyrotron and high power microwave research outside the US was discussed. We also presented talks on "A quasi-optical mode converter for gyrotrons operating in high order modes" and "High frequency, megawatt gyrotron experiments at M.I.T."

7868 (DOE/FTR–94001876) **Travel to Germany and Italy for meetings on fusion reactor materials: Foreign trip report, September 21–October 8, 1993.** Longhurst, G.R. EG and G Idaho, Inc., Idaho Falls, ID (United States). 25 Oct 1993. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE94001876. Source: OSTI; NTIS (US Sales Only); GPO Dep.

The report summarizes technical presentations in the Carbon Materials workshop, but for the other meetings, only those technical points of particular interest to fusion safety concerns or other programmatic activities are related. Also, I had a number of conversations with researchers and presenters. Where those conversations are of interest, they are also related. I toured a number of facilities, but no effort is made to describe them here since they are well known. Attachments to the report include attendee lists and agendas for the meetings and a summary of a concept for a collaborative research program that may may involve the INEL and JRC Ispra.

7869 (DOE/FTR–94002747) **Travel to Italy for Workshop on Plasma Edge Theory in Fusion Devices: Foreign trip report, October 1–10, 1993.** Rognlien, T.D. Lawrence Livermore National Lab., CA (United States). 28 Oct 1993. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94002747. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This workshop has always been held in Europe and focuses on progress in theoretical analysis of edge plasmas in fusion devices; both analytical and numerical work was presented. Local arrangements were made by the Max Planck Institute fuer Plasmaphysik, Garching, Germany in cooperation with KFA Juelich, Germany, the European Community, the USDOE, and the International School of Plasma Physics, "Piero Caldirola," in Varenna. The plan is to hold the meeting in the US in 1995, in order to be on alternate years with the Plasma Surface Interaction Conference which focuses more on experimental edge plasma results. As a brief summary, a number of codes have investigated gaseous diverters, and typically find that very high gas and/or plasma densities are required to remove the exhaust power for ITER. Impurity injection reduces the density needed but it is difficult for the impurities to penetrate unless by some type of direct (pellet) injection. Existing fluid models are lacking adequate kinetic descriptions of several physical processes. Theory has identified a number of instability mechanism for turbulence. While nonlinear analysis is in its early stages, some scaling of anomalous diffusion coefficients to new devices is possible. Comparison of theory and codes with experimental data needs more attention. I found the meeting very helpful for learning the present status of edge plasma theory and for discussing our results with other researchers.

7870 (DOE/FTR–94004970) **Travel to Switzerland to discuss the design of the ITER long-length quench experiment: Foreign trip report, November 14–21, 1993.** Schultz, J. Massachusetts Inst. of Tech., Cambridge, MA (United States). Plasma Fusion Center. 19 Nov 1993. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC02-93ER54186. Order Number DE94004970. Source: OSTI; NTIS (US Sales Only); GPO Dep.

On Nov. 16-17, the author met with Drs. George Vecsey, Alexander Anghel, and Ingo Rohleder of the Paul Scherrer Institute in Villigen, Switzerland, to discuss the design of the ITER long-length quench experiment. The purpose of the meetings with laboratory personnel was to exchange information on the laboratory facilities and the U.S. contribution to the experiment, while exploring areas of technical agreement and disagreement. On Nov. 18-19, he met with Nishio Koizumi of JAERI, A. Anghel, G. Vecsey, Claudio Marinucci and Gabriel Pasztor of PSI,and Heinrich Katheder of NET, in order to reach an agreement on the characteristics of the long-length quench experiment (LLQE) design.

7871 (GA-A–21426) **Surface impurity removal from DIII-D graphite tiles by boron carbide grit blasting.** Lee, R.L.; Hollerbach, M.A.; Holtrop, K.L.; Kellman, A.G.; Taylor, P.L.; West, W.P. General Atomics, San Diego, CA (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. (CONF-931018–71: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94004188. Source: OSTI; NTIS; INIS; GPO Dep.

During the latter half of 1992, the DIII-D tokamak at General Atomics (GA) underwent several modifications of its interior. One of the major tasks involved the removal of accumulated metallic impurities from the surface of the graphite tiles used to line the plasma facing surfaces inside of the tokamak. Approximately 1500 graphite tiles and 100 boron nitride tiles from the tokamak were cleaned to remove the metallic impurities. The cleaning process consisted of several steps: the removed graphite tiles were permanently marked, surface blasted using boron carbide (B_4C) grit media (approximately 37 μm. diam.), ultrasonically cleaned in ethanol to remove loose dust, and outgassed at 1000°C. Tests were done using, graphite samples and different grit blaster settings to determine the optimum propellant and abrasive media pressures to remove a graphite layer approximately 40-50 μm deep and yet produce a reasonably smooth finish. EDX measurements revealed that the blasting technique reduced the surface Ni, Cr, and Fe impurity levels to those of virgin graphite. In addition to the surface impurity removal, tritium monitoring was performed throughout the cleaning process. A bubbler system was set up to monitor the tritium level in the exhaust gas from the grit blaster unit. Surface wipes were also performed on over 10% of the tiles. Typical surface tritium concentrations of the tiles were reduced from about 500 dpm/100 cm^2 to less than 80 dpm/100 cm^2 following the cleaning. This tile conditioning, and the installation of additional graphite tiles to cover a high fraction of the metallic plasma facing surfaces, has substantially reduced metallic impurities in the plasma discharges which has allowed rapid recovery from a seven-month machine opening and regimes of enhanced plasma energy confinement to be more readily obtained. Safety issues concerning blaster operator exposure to carcinogenic metals and radioactive tritium will also be addressed.

7872 (GA-A–21445) **Upgrade of DIII-D toroidal magnetic field power supply controls.** Petrach, P.M.; Rouleau, A.R.; McNulty, R.D.; Patrick, D.B.; Walin, J.L. General Atomics, San Diego, CA (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. (CONF-931018–70: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94004184. Source: OSTI; NTIS; INIS; GPO Dep.

The toroidal magnetic field power supply for the DIII-D tokamak is of the 12 pulse line commutated variety. It consists of four individual modules and a main system control cabinet which are combined to deliver 127,000 A and 1000 V to the toroidal field coil. The modules are connected in a series-parallel configuration but can be run alone or two at a time as well. Normally on DIII-D experiments, the series-parallel configuration is required. The original design provided each individual module with its own voltage and current control loop and a main control loop. A problem with this design was that the individual control loops would cause a current sharing imbalance in the parallel modules if the calibrated loops drifted by the slightest amount. It was determined that individual control loops were not needed and a single phase lock firing circuit

was employed in the system cabinet with fiber optic links to the modules for gate drive signals. Since all four modules have to be on line for DIII-D to operate, a problem in any of the five E&I control loops resulted in the supply, and, therefore, the tokamak, being idled. By reducing the number of control loops to one, the sharing problem was eliminated, as well as 4 out of 5 potential control failures. The original supply employed relay logic for sequence control and fault monitoring. There were over 130 relays in each module plus an additional 100 in the system cabinet. The combination of the number of relays with the required interconnecting wiring, the age of the supply, the vibrations of the cabinets and the harsh environment, resulted in a continuously escalating number of phantom, and often intermittent, faults. The fault and sequence logic relays were replaced by a new Programmable Logic Controller (PLC). All existing interconnect wire was removed and replaced with multiconductor cables that connect directly from fault sensors and input devices to the PLC.

7873 (GA-A–21485) **A robust helium-cooled shield/blanket design for ITER.** Wong, C.P.C. (and others); Bourque, R.F.; Baxi, C.B. General Atomics, San Diego, CA (United States). Nov 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. (CONF-931018–61: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94003402. Source: OSTI; NTIS; INIS; GPO Dep.

General Atomics Fusion and Reactor Groups have completed a helium-cooled, conceptual shield/blanket design for ITER. The configuration selected is a pressurized tubes design embedded in radially oriented plates. This plate can be made from ferritic steel or from V-alloy. Helium leakage to the plasma chamber is eliminated by conservative, redundant design and proper quality control and inspection programs. High helium pressure at 18 MPa is used to reduce pressure drop and enhance heat transfer. This high gas pressure is believed practical when confined in small diameter tubes. Ample industrial experience exists for safe high gas pressure operations. Inboard shield design is highlighted in this study since the allowable void fraction is more limited. Lithium is used as the thermal contacting medium and for tritium breeding, its safety concerns are minimized by a modular, low inventory design that requires no circulation of the liquid metal for the purpose of heat removal. This design is robust, conservative, reliable, and meets all design goals and requirements. It can also be built with present-day technology.

7874 (GA-A–21494) **ARIES-IV Nested Shell Blanket Design.** Wong, C.P.C. (General Atomics, San Diego, CA (United States)); Redler, K.; Reis, E.E.; Will, R.; Cheng, E.; Hasan, C.M.; Sharafat, S. General Atomics, San Diego, CA (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. (CONF-931018–62: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94003403. Source: OSTI; NTIS; INIS; GPO Dep.

The ARIES-IV Nested Shell Blanket (NSB) Design is an alternate blanket concept of the ARIES-IV low activation helium-cooled reactor design. The reference design has the coolant routed in the poloidal direction and the inlet and outlet plena are located at the top and bottom of the torus. The NSB design has the high velocity coolant routed in the toroidal direction and the plena are located behind the blanket. This is of significance since the selected structural material is SiC-composite. The NSB is designed to have key high performance components with characteristic dimensions of no larger than 2 m. These components can be brazed to form the blanket module. For the diverter design, we eliminated the use of W as the divertor coating material by relying on the successful development of the gaseous divertor concept. The neutronics and thermal-hydraulic performance of both blanket concepts are similar. The selected blanket and divertor configurations can also meet all the projected structural, neutronics and thermal-hydraulics design limits and requirements. With the selected blanket and divertor materials, the design has a level of safety assurance rate of I (LSA-1), which indicates an inherently safe design.

7875 (INIS-mf–13761) **Report 1991-1992 Association Euratom-Confederation Suisse.** Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). May 1993. 148p. Order Number DE94611506. Source: OSTI; NTIS; INIS.

This is the first integrated biannual report of the Swiss-Euratom Association, one of the twelve Associations of the European programme for controlled nuclear fusion research. Up until now, each Swiss group presented its activities within the framework of the institution to which it belonged. The report of the CRPP, whose research is almost entirely dedicated to fusion, gave a good picture of the Swiss programme in physics but the important technological activities of the PSI were described separately in the PSI report, out of its natural context and buried amongst a multitude of other projects. We hope that this report will contribute to a better knowledge of the Association and appreciation of its work. It is also the answer to an old Euratom desire to have each Association publish such an integrated report of its activities. (author) 69 figs., tabs., refs.

7876 (IPP–1/274) **The new centrifuge high-speed pellet injector for ASDEX Upgrade.** Lang, P.T.; Andelfinger, C.; Beck, W.; Buchelt, E.; Buechl, K.; Cierpka, P.; Kollotzek, H.; Lang, R.S.; Prausner, G.; Soeldner, F.X.; Ulrich, M.; Weber, G. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany). Apr 1993. 30p. Order Number DE94734001. Source: OSTI; NTIS (US Sales Only); INIS.

We report on the new pellet injection system for refuelling the ASDEX Upgrade tokamak with cubic H_2 or D_2 pellets having alternative side lengths of 1.5, 1.75 and 2.0 mm and optional Ne doping. The system delivers series of about one hundred pellets at a maximum repetition rate of more than 40 Hz. The pellets are accelerated by means of a centrifuge with an optimized straight acceleration arm. This configuration minimizes the compulsive force acting on the pellet during the acceleration process. Since this also minimizes stresses inside the pellet, high velocities - a maximum of 1211 m/s being achieved - are possible without destroying the hydrogen cubes. A special pellet feed-in technique based on a static stop cylinder interrupting the acceleration path successfully reduced the horizontal scattering angle to values of less than $\pm$ 4 degrees. Thus, a high efficiency - with more than 90% of the pellets arriving within the acceptance angle - was achieved without using a guide tube. The whole system was found to work very reliably and reproducibly during the whole test operation period, covering about 10^5 pellet shots. The new centrifuge, now integrated into the ASDEX Upgrade setup, has proved to be a reliable unit even for long operation periods thus affording the possibility of quasicontinuous particle refuelling throughout a plasma discharge in ASDEX Upgrade. (orig.)

7877 (IPP–3/189) **The isotope effect in ASDEX.** Bessenrodt-Weberpals, M.; Wagner, F. ASDEX Team. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany). Jan 1993. 75p. Order Number DE94734002. Source: OSTI; NTIS (US Sales Only); INIS.

This paper describes the effect of the isotopic mass on plasma parameters as observed in the ASDEX tokamak. The paper comprises Ohmic as well as L-mode, H-mode and H*-mode scenarios. The measurements reveal that the ion mass is a substantial and robust parameter which affects all confinement times (energy, particle and momentum) in the whole operational window. Both, core properties like the sawtooth repetition time and edge properties like the separatrix density change with the isotopic mass. Specific emphasis is given to the edge parameters and changes of the edge plasma due to different wall conditioning such as carbonization and boronization. The pronounced isotope dependence of edge and divertor parameters are explained by the secondary effect of different power fluxes into the scrape-off layer plasma and onto the divertor plates. Finally, the observations serve to test different transport theories. With respect to the ion temperature gradient driven turbulence, the isotope effect is also studied in pellet refuelled discharges with peaked density profiles. The results from ASDEX are compared with those from other experiments. (orig.)

7878 (IPP–5/51) **Profile constraining mechanism for T_e profile invariance in tokamaks.** Becker, G. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany). Mar 1993. 14p. Order Number DE94733999. Source: OSTI; NTIS (US Sales Only); INIS.

A new model for the electron temperature profile resilience in the outer half of tokamak plasmas is proposed and investigated. It is

shown that introducing a negative feedback term into the scaling of the electron heat diffusivity $\chi_e(r) = \chi_{ee}(r)(1-\alpha a^2/T_{eo}\ d^2T_e/dr^2)$ with $\alpha >$ or ≈ 3 results in the observed T_e profile stiffness against variations of the density and heating profiles. In addition, the feedback by itself yields the measured approximately linear $T_e(r)$ shape for $r/a >$ or ≈ 0.5 in contrast to previous profile constraining models. (orig.). 6 figs.

7879 (KFK–5060) **CETA, a step towards a low activation martensitic steel.** Anderko, K.; Ehrlich, K.; Schaefer, L.; Schirra, M. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Materialforschung; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion. Jun 1993. 53p. (In German). Order Number DE94734059. Source: OSTI; NTIS (US Sales Only); INIS.

The conventional martensitic 9-12% CrMoV Nb steel, type MANET/W.nr. 1.4914, an European reference, shows promising properties for an application as "First Wall" - and as structural material for fusion devices. One of few drawbacks is the high neutron-induced, longterm activation through elements like Mo, Ni and Nb. The substitution of these important alloying elements by W and Ta leads to a new group of 8-10% Cr W V Ta alloys, to which the steel CETA belongs. Activation calculations indicate that a reduction of longterm activation can be achieved through this compositional change. Investigations of CETA revealed that this new steel is fully martensitic without any δ-ferrite formation, and grain-refinement can fully be achieved by Ta alloying. The alloy exhibits good hardenability and tempering behaviour. The transformation behaviour is very similar to that of the CrMoVNb steels. The tensile-, creep- and creep rupture-properties satisfy the requirements, the impact properties correspond to the values measured for the MANET material. Further improvement of all properties seems to be possible through optimization of the chemical composition of this new steel. (orig.)

7880 (KFK–5104) **Gas purification by use of hot metal getter beds.** Albrecht, H. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Radiochemie; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion. Nov 1992. 68p. Order Number DE94734013. Source: OSTI; NTIS (US Sales Only); INIS.

An experimental program is described which was performed in the frame of a tritium technology task for the NET/ITER fusion fuel cycle. The aim was to investigate commercial gas purifiers containing metallic getters for the purification of gas streams such as the plasma exhaust gas. Five purifiers with up to 3000g of getter material were tested in the PEGASUS facility mainly with respect to the removal of methane, which is known to be much more difficult to remove than other impurities like O_2, N_2, or CO. A proposal for a fuel cleanup method based on a combination of getter beds and Pd/Ag diffusors is presented as the main conclusion of the test program. The discussion of this method includes the aspects of flow rates, tritium inventory, and consumption of getter material. (orig.)

7881 (LA-UR–93-3647) **Recovery of hydrogen from impurities using a palladium membrane reactor.** Willms, R.S. (Los Alamos National Lab., NM (United States)); Okuno, K. Los Alamos National Lab., NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States);Japan Atomic Energy Research Inst., Tokyo (Japan). DOE Contract W-7405-ENG-36. (CONF-931018–69: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94003976. Source: OSTI; INIS; NTIS; GPO Dep.

One of the important steps in processing the exhaust from a fusion reactor is recovering tritium which is incorporated into molecules such as water and methane. One device which may prove to be very effective for this purpose is a palladium membrane reactor. This is a reactor which incorporates a Pd/Ag membrane in the reactor geometry. Reactions such as water gas shift, steam reforming and methane cracking can be carried out over the reactor catalyst, and the product hydrogen can be simultaneously removed from the reacting mixture. Because product is removed, greater than usual conversions can be obtained. In addition ultrapure hydrogen is produced, eliminating the need for an additional processing step. A palladium membrane reactor has been built and tested with three different catalysts. Initial results with a Ni-based catalyst show that it is very effective at promoting all three reactions listed above. Under the proper conditions, hydrogen recoveries approaching 100% have been observed. This study serves to experimentally validate the palladium membrane reactor as potentially important tool for fusion fuel processing.

7882 (LA-UR–93-3655) **Cryogenic adsorption of low-concentration hydrogen on charcoal, 5A molecular sieve, sodalite, ZSM-5 and Wessalith DAY.** Willms, R.S. Los Alamos National Lab., NM (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931018–68: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94003975. Source: OSTI; NTIS; INIS; GPO Dep.

The separation of low-concentration hydrogen isotopes from helium is a processing step that is required for ceramic lithium breeding blanket processing. Cryogenic adsorption is one method of effecting this separation. In this study live adsorbents were considered for this purpose: charcoal, 5A molecular sieve, UOP S-115, ZSM-5 and Wessalith DAY. The first two adsorbents exhibit good equilibrium loadings and are shown to be quite effective at adsorbing low-concentration hydrogen isotopes. The latter three adsorbents display considerably lower equilibrium loadings. This study concludes that by using either charcoal or 5A molecular sieve, cryogenic adsorption would be an effective means of separating hydrogen isotopes from helium.

7883 (LA-UR–93-3665) **Application of sidestream recycle to the separation of hydrogen isotopes by cryogenic distillation.** Sherman, R.H. (Los Alamos National Lab., NM (United States)); Taylor, D.J.; Barnes, J.W.; Yamanishi, T.; Enoeda, M.; Konishi, S.; Okuno, K. Los Alamos National Lab., NM (United States). [1993]. 4p. Sponsored by USDOE, Washington, DC (United States);Japan Atomic Energy Research Inst., Tokyo (Japan). DOE Contract W-7405-ENG-36. (CONF-931018–44: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94002713. Source: OSTI; NTIS; INIS; GPO Dep.

Withdrawal of a sidestream from an isotopic-separation distillation column followed by equilibration of species and reinjection is a technique for reducing the required number of columns and hence reducing tritium inventories in fusion-energy fuel processing systems. Measurements have been made with a single column and the three-component H_2-HD-D_2 system withdrawing streams of essentially pure H_2 and D_2. This was followed by single column measurements with the full HDT system and a column inventory of ca. 16.8 moles (H/D/T = 0.043/0.528/0.429). Rather pure T_2 (ca. 98.7 mol%) was produced as one of the products. This would previously have required two separate distillation columns with an inventory of ca. 16 moles of T_2 as compared with 7.2 moles of T_2 in these experiments. The dynamic response of the H-D system was followed using in-situ laser Raman spectroscopy to obtain product compositions and column composition profiles.

7884 (LA-UR–93-4234) **Performance of a 14-MeV neutron generator as an in situ calibration source for TFTR.** Roquemore, A.L. (Princeton Univ., NJ (United States). Plasma Physics Lab.); Jassby, D.L.; Johnson, L.C.; Strachan, J.D.; Barnes, C.W. Los Alamos National Lab., NM (United States); Princeton Univ., NJ (United States). Plasma Physics Lab. 14 Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36 ; AC02-76CH03073. (CONF-931018–77: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94004993. Source: OSTI; NTIS; INIS; GPO Dep.

TFTR will soon enter its D-T phase with the introduction of tritium. This will result in the production of neutrons having 14-MeV energy which is significantly greater than the 2.5-MeV neutrons encountered during D-D operation. In preparation for the D-T phase, a calibration of the four neutron detection systems was performed using a 14-MeV neutron generator producing 10^8 n/sec. To account for the spatial extent of the toroidally shaped plasma and for neutrons scattered from surrounding structures, detector responses were determined with the source positioned at many locations inside the vacuum vessel. Before the generator could be used as a calibration source, a characterization of its total yield and angular emission properties was obtained. The total yield was determined by aluminum activation methods to within $\pm 6\%$, while the angular

emission was found to be anisotropic in the forward and reverse cones along the generator axis. After the characterization was performed, the generator was mounted on a moveable track inside the vacuum vessel, where it could be remotely moved across the view of each detector. This paper presents details of the methods and results of the source characterization, together with initial results of the in-vessel D-T neutron calibration.

7885 (LA-UR–93-4482) **Atomic processes in Inertial Electrostatic Confinement (IEC) devices.** Nebel, R.A. (Los Alamos National Lab., NM (United States)); Turner, L.; Tiouririne, T.N.; Barnes, D.C.; Nystrom, W.D.; Bussard, R.W.; Miley, G.H.; Javedani, J.; Yamamoto, Y. Los Alamos National Lab., NM (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9309119–2: 9. biennial topical conference on atomic processes in plasmas, San Antonio, TX (United States), 19-23 Sep 1993). Order Number DE94005015. Source: OSTI; NTIS; INIS; GPO Dep.

Inertial Electrostatic Confinement (IEC) is one of the earliest plasma confinement concepts, having first been suggested by P. T. Farnsworth in the 1950s. The concept involves a simple apparatus of concentric spherical electrostatic grids or a combination of grids and magnetic fields. An electrostatic structure is formed from the confluence of electron or ion beams. Gridded IEC systems have demonstrated neutron yields as high as $2*10^{10}$ neutrons/sec. These systems have considerable potential as small, inexpensive, portable neutron sources for assaying applications. Neutron tomography is also a potential application. Atomic physics effects strongly influence the performance of all of these systems. Important atomic effects include elastic scattering, ionization, excitation, and charge exchange. This paper discusses how an IEC system is influenced by these effects and how to design around them. Theoretical modeling and experimental results are presented.

7886 (LBL–33798) **The induction approach to heavy ion inertial fusion: Accelerator and target considerations.** Bangerter, R.O. Lawrence Berkeley Lab., CA (United States). Aug 1993. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (HIFAN–577; CONF-9305136–16: International symposium on heavy ion fusion, Frascati (Italy), 25-28 May 1993). Order Number DE94005216. Source: OSTI; NTIS; INIS; GPO Dep.

Induction acceleration is one of two principal approaches for producing ion beam for heavy-ion inertial fusion. This approach was first suggested by the late Denis Keefe of Lawrence Berkeley Laboratory and is the main approach of the US heavy-ion-fusion program. Induction accelerators have the ability to handle high beam currents; therefore, accumulation rings or storage rings are not required. This paper reviews the target and accelerator considerations that are important for the design of induction accelerators for fusion. These considerations, including some important assumptions, have led to a standard induction accelerator concept; however, a careful examination of the assumptions and considerations shows that many of them are not truly fundamental. Through improvements in technology, changes in design, and alternate ways of focusing beams, it appears possible to circumvent or relax the constraints imposed by the standard orthodoxy. If it is possible, it will lead to induction accelerators that are more efficient and less costly than the standard concept.

7887 (LBL–34231) **Heavy Ion Fusion Accelerator Research at the Lawrence Berkeley Laboratory.** Fessenden, T.J. Lawrence Berkeley Lab., CA (United States). Oct 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-930929–1: 7. international conference on emerging nuclear energy systems, Makuhari (Japan), 20-24 Sep 1993). Order Number DE94003255. Source: OSTI; NTIS; INIS; GPO Dep.

Since 1993, US research toward a heavy ion inertial fusion driver has concentrated on the multiple-beam ion-induction linac. This type of accelerator is unique in its ability to continuously amplify both the beam current and energy during the acceleration process. In a conceptual driver, many beams are accelerated in parallel through common induction cores in a linac that is 5–10 km long to final energies near 10 GeV in less than 0.2 msec. Past experiments at LBL have investigated the transport of intense ion beams in alternating gradient focusing structures and the acceleration of multiple ion becomes with current amplification in an induction linac. At present our major project is the development of a pulsed, 2-MV injector that produces beams at full driver size and intensity. In addition, a major activity is the development of a physics and engineering design for a larger Induction Linac Systems Experiments (ILSE) to test in a scaled way almost all the manipulations needed in a full-scale driver. We hope to begin construction of this experiment near the beginning of 1995.

7888 (NIIYaF-MGU–92-39-288) **On physical aspects of a thermonuclear reactor with a vacuum gap between plasma and first wall.** Gertsenshtejn, M.E.; Klavdiev, V.V. Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1992. 39p. (In Russian). Order Number DE94611509. Source: OSTI; NTIS (US Sales Only); INIS.

The problem of controlled thermonuclear synthesis of rarefied plasma, confining by magnetic field, exists about 40 years. At the present time the problem solution follows in the traditional way of transition to larger and more expensive facilities. The way is near to saturation and its perspectives are vague. For the reasons takes place sharp decreasing of financing. Taking into account for the considerations it is expedient to analyse a nontraditional way, when between the plasma filament and first wall is formed a vacuum gap. Physical aspects of the way are considered in the paper. 28 refs.; 8 figs.

7889 (PNL-SA–22456) **Relationship between swelling and irradiation creep in cold-worked PCA stainless steel irradiated to ~178 dpa at ~400°C.** Toloczko, M.B. (Univ. of California, Santa Barbara, CA (United States). Dept. of Chemical and Nuclear Engineering); Garner, F.A. Pacific Northwest Lab., Richland, WA (United States); Northwest Coll. and Univ. Association for Science, Richland, WA (United States). Sep 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830 ; FG06-89ER75522. (CONF-930928–19: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94004368. Source: OSTI; NTIS; INIS; GPO Dep.

The eighth and final irradiation segment for pressurized tubes constructed from the fusion Prime Candidate Alloy (PCA) has been completed in FFTF. At 178 dpa and ~400°C, the irradiation creep of 20% cold-worked PCA has become dominated by the "creep disappearance" phenomenon. The total diametral deformation rate has reached the limiting value of 0.33%/dpa at the three highest stress levels employed in this test. The stress-enhancement of swelling tends to camouflage the onset of creep disappearance, however, requiring the use of several non-traditional techniques to extract the creep coefficients. No failures occurred in these tubes, even though the swelling ranged from ~20 to ~40%.

7890 (PNL-SA–22470) **Microstructural development in irradiated vanadium alloys.** Gelles, D.S. (Pacific Northwest Lab., Richland, WA (United States)); Stubbins, J.F. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930928–15: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94004307. Source: OSTI; NTIS; INIS; GPO Dep.

Three simple vanadium alloys, V-5Al, V-1Ni, and V-2Ti-1Ni have been examined to determine the effects of fast neutron irradiation on microstructural evolution. Specimens were irradiated in EBR II at temperatures in the range 425 to 600°C to doses of 15 and 31 dpa. Each alloy responded very differently to irradiation. All V-5Al specimens were generally void-free and contained high densities of coherent precipitates, and moderate densities of network dislocations. Swelling was much higher in V-1Ni. Voids were uniformly distributed, but with widely varying shape and size. Precipitation of two types also developed. The response in V-2Ti-1Ni was intermediate to that of the other two alloys. Irradiation produced extensive precipitation of thin rods and a moderate density of large voids often associated with much larger precipitate particles. The dislocation structure strongly interacted with the rod precipitate particles.

7891 (PNL-SA–22489) **Modeling defect production in high energy collision cascades.** Heinisch, H.L. (Pacific Northwest Lab., Richland, WA (United States)); Singh, B.N.; Diaz de la Rubia, T. Pacific Northwest Lab., Richland, WA (United States). [1993]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930928–11: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94003810. Source: OSTI; NTIS; INIS; GPO Dep.

A multi-model approach roach (MMA) to simulating defect production processes at the atomic scale is described that incorporates molecular dynamics (MD), binary collision approximation (BCA) calculations and stochastic annealing simulations. The central hypothesis of the MMA is that the simple, fast computer codes capable of simulating large numbers of high energy cascades (e.g., BCA codes) can be made to yield the correct defect configurations when their parameters are calibrated using the results of the more physically realistic MD simulations. The calibration procedure is investigated using results of MD simulations of 25 keV cascades in copper. The configurations of point defects are extracted from the MD cascade simulations at the end of the collisional phase, similar to the information obtained with a binary collision model. The MD collisional phase defect configurations are used as input to the ALSOME annealing simulation code, and values of the ALSOME quenching parameters are determined that yield the best fit to the post-quenching defect configurations of the MD simulations.

7892 (PNL-SA–22545) **Effect of loading mode on the fracture toughness of a reduced activation ferritic/martensitic stainless steel.** Li, H. (Washington State Univ., Pullman, WA (United States)); Hirth, J.P.; Jones, R.H.; Gelles, D.S. Pacific Northwest Lab., Richland, WA (United States). Sep 1993. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930928–16: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94004290. Source: OSTI; NTIS; INIS; GPO Dep.

The critical J integrals of mode I (J_{IC}), mixed-mode I/III (J_{MC}), and mode III (J_{IIIC}) were examined for a ferritic stainless steel (F-82H) at ambient temperature. A determination of J_{MC} was made using modified compact-tension specimens. Different ratios of tension/shear stress were achieved by varying the principal axis of the crack plane between 0 and 55 degrees from the load line. The results showed that J_{MC}s and tearing moduli (T_M) varied with the crack angles and were lower than their mode I and mode III counterparts. Both the minimum J_{MC} and T_M occurred at a crack angle between 40 and 50 degrees, where σ_I/σ_{III} was 1.2 to 0.84. The J_{min} was 240 kJ/m^2, and ratios of J_{IC}/J_{min} and J_{IIIC}/J_{min} were about 2.1 and 1.9, respectively. Morphology of fracture surfaces was consistent with the change of J_{MC} and T_M values. While the upper shelf-fracture toughness of F-82H depends on loading mode, the J_{min} remains very high. Other important considerations include the effect of mixed-mode loading on the DBT temperature, and effects of hydrogen and irradiation on J_{min}.

7893 (PNL-SA–23419) **Fundamentals of defect production.** Heinisch, H.L. Pacific Northwest Lab., Richland, WA (United States). [1993]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-930928–23: 6. international conference on fusion reactor materials, Stresa (Italy), 27 Sep - 1 oct 1993). Order Number DE94004779. Source: OSTI; NTIS; INIS; GPO Dep.

This short paper discusses modeling radiation damage in the role of cluster production and mobility in thermonuclear reactor materials.

7894 (PPPL–2945) **Wall conditioning experiments on TFTR using impurity pellet injection.** Strachan, J.D. (and others); Mansfield, D.K.; Bell, M.G. Princeton Univ., NJ (United States). Plasma Physics Lab. Nov 1993. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03073. Order Number DE94005544. Source: OSTI; NTIS; INIS; GPO Dep.

This work describes experiments intended to optimize the limiter conditioning for TFTR supershots. It is shown that deposition of thin layers of lithium on the limiters by impurity pellet injection changes the plasma-wall interaction and improves supershot performance. Series of up to ten Ohmic plasmas each with two lithium pellets were useful in preconditioning the limiter. Generally, plasma performance increased with the amount of lithium deposited up to the maximal amount which could be deposited. Experiments were performed with different materials being deposited (carbon, boron and lithium) and with different methods of deposition.

7895 (SAND–93-2512C) **The light ion LMF and its relevance to IFE.** Olson, R.E.; Allshouse, G.O.; Cook, D.L.; Lockner, T.R.; Mazarakis, M.G.; Olson, C.L.; Smith, D.L. Sandia National Labs., Albuquerque, NM (United States). 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-931018–67: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94003774. Source: OSTI; NTIS; INIS; GPO Dep.

The inertial confinement fusion (ICF) program at Sandia National Laboratories (SNL) is directed toward validating light ions as an efficient driver for ICF defense and energy applications. The light ion laboratory microfusion facility (LMF) is envisioned as a facility in which high gain ICF targets could be developed and utilized in defense-related experiments. The relevance of LMF technology to eventual inertial fusion energy (IFE) applications is assessed via a comparison of LMF technologies with those projected in the Light Ion Beam Reactor Assessment (LIBRA) conceptual reactor design study.

7896 (UCRL-ID–115480) **Scaling 2XIIB impurity radiation to BPNS.** Molvik, A.W. Lawrence Livermore National Lab., CA (United States). 3 Dec 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004028. Source: OSTI; NTIS; INIS; GPO Dep.

In this paper the author computes the radiative power losses which would be expected from the beam-plasma neutron source, which is proposed as a neutron source for doing accelerated end-of-life testing of fusion reactor materials. The source is based on a high density tritium target, bombarded with a deuterium beam of energy 120 to 150 keV. Oxygen was observed to be a major source of power loss for beam injection into the 2XIIB device, and the author considers that problem here. Oxygen impurities are a small component of the beam. The analysis indicates that higher charge states are reached in this device, resulting in less power radiation from oxygen impurities, and the beam is expected to attain higher purity levels at pulse lengths in the seconds range, than was observed in the past for millisecond pulse lengths.

7897 (UCRL-ID–115904) **Advanced steady-state operating scenarios.** Nevins, W.M. (Lawrence Livermore National Lab., CA (United States)); Bulmer, R.H.; Pearlstein, L.D.; Haney, S.W.; Manickam, J. Lawrence Livermore National Lab., CA (United States). 2 Dec 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94004810. Source: OSTI; NTIS; INIS; GPO Dep.

The goal for advanced steady-state operation in ITER should be to demonstrate the operation of the plasma core for a steady-state fusion reactor. To accomplish this the authors must develop steady-state operating scenarios at high beta for high fusion power density, low auxiliary power requirements ($Q_{CD} \geq 25$, where $Q_{CD} \equiv P$ fusion/P_{CD} and P_{DC} is the power required for sustaining the plasma current) for low recirculating power requirements, and at moderate safety factor ($q_\psi \leq 4.5$) to minimize the cost for the tokamak core of a steady-state demonstration power reactor based on the operating modes demonstrated in ITER. The key to achieving steady-state operation at high fusion power in ITER will be the development of operating scenarios with very high bootstrap current fractions ($f_{BS} \geq 90\%$) in which the radial profile of the bootstrap current density is well aligned with that of the total plasma current density, and for which the MHD β-limit exceeds $\beta_n^* = 0.05$ T−m/MA. They are in the process of developing such operating modes for ITER. In §1 they propose two advanced steady-state operating points; a preliminary operating point that was the basis for the MHD studies reported in §2, and a second operating point that has been optimized based on the authors studies to date. In §2 they present calculations indicating that the initial operating point is stable to MHD ballooning and low-n kink modes (with a conducting wall at r = 1.25a) up to $\beta_n^* \approx 6 \times 10^{-2}$ T − m/MA. In §3 they

present a free-boundary MHD equilibrium, and show that advanced steady-state operating modes are compatible with the ITER poloidal field system and diverter.

7898 (UCRL-JC–115616) **Optimization of the National Ignition Facility primary shield design.** Annese, C.E. (California Univ., Berkeley, CA (United States). Dept. of Nuclear Engineering); Watkins, E.F.; Greenspan, E.; Miller, W.F.; Latkowski, J.; Lee, J.D.; Soran, P.; Tobin, M.L. Lawrence Livermore National Lab., CA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-931018–63: Symposium on fusion engineering, Hyannis, MA (United States), 11-15 Oct 1993). Order Number DE94003622. Source: OSTI; NTIS; INIS; GPO Dep.

Minimum cost design concepts of the primary shield for the National Ignition laser fusion experimental Facility (NIF) are searched with the help of the optimization code SWAN. The computational method developed for this search involves incorporating the time dependence of the delayed photon field within effective delayed photon production cross sections. This method enables one to address the time-dependent problem using relatively simple, time-independent transport calculations, thus significantly simplifying the design process. A novel approach was used for the identification of the optimal combination of constituents that will minimize the shield cost; it involves the generation, with SWAN, of effectiveness functions for replacing materials on an equal cost basis. The minimum cost shield design concept was found to consist of a mixture of polyethylene and low cost, low activation materials such as SiC, with boron added near the shield boundaries.

99 GENERAL AND MISCELLANEOUS

7899 (DOE-STD–0103T) **TAP 3: Training Program Support Manual.** USDOE, Washington, DC (United States). Aug 1993. 206p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94003653. Source: OSTI; NTIS; INIS; GPO Dep.

Superseding DOE/NE-0103T.

The Training Accreditation Program (TAP) establishes objectives and criteria against which DOE nuclear facility training is evaluated to determine readiness for accreditation. TAP 3 has been developed to assist the contractor in preparing the initial Self-Evaluation Report, Training Program Accreditation Plan, and the CSER (contractor self-evaluation report).

9901 Management

Refer also to citation(s) 6277, 6765, 6912, 7381

7900 (LA-UR–93-3566) **Practical problems in aggregating expert opinions.** Booker, J.M.; Picard, R.R.; Meyer, M.A. Los Alamos National Lab., NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–38: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94002623. Source: OSTI; NTIS; GPO Dep.

Expert opinion is data given by a qualified person in response to a technical question. In these analyses, expert opinion provides information where other data are either sparse or non-existent. Improvements in forecasting result from the advantageous addition of expert opinion to observed data in many areas, such as meteorology and econometrics. More generally, analyses of large, complex systems often involve experts on various components of the system supplying input to a decision process; applications include such wide-ranging areas as nuclear reactor safety, management science, and seismology. For large or complex applications, no single expert may be knowledgeable enough about the entire application. In other problems, decision makers may find it comforting that a consensus or aggregation of opinions is usually better than a single opinion. Many risk and reliability studies require a single estimate for modeling, analysis, reporting, and decision making purposes. For problems with large uncertainties, the strategy of combining as diverse a set of experts as possible hedges against underestimation of that uncertainty. Decision makers are frequently faced with the task of selecting the experts and combining their opinions. However, the aggregation is often the responsibility of an analyst. Whether the decision maker or the analyst does the aggregation, the input for it, such as providing weights for experts or estimating other parameters, is imperfect owing to a lack of omniscience. Aggregation methods for expert opinions have existed for over thirty years; yet many of the difficulties with their use remain unresolved. The bulk of these problem areas are summarized in the sections that follow: sensitivities of results to assumptions, weights for experts, correlation of experts, and handling uncertainties. The purpose of this paper is to discuss the sources of these problems and describe their effects on aggregation.

7901 (PNL-SA–22737) **Using multi-disciplinary strategic master facilities planning for organizations experiencing programmatic re-direction.** Heubach, J.G.; Weimer, W.C.; Bruce, W.A. Pacific Northwest Lab., Richland, WA (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9310100–5: Human Factors and Ergonomics Society meeting, Seattle, WA (United States), 11-15 Oct 1993). Order Number DE94003729. Source: OSTI; NTIS; GPO Dep.

Facility master planning is critical to the future productivity of a laboratory and the quality of worklife for the laboratory staff. For organizations undergoing programmatic re-direction, a master facility planning approach linked to the organization's strategic planning process is even more important. Major changes in an organization such as programmatic re-direction can significantly impact a broad range of variables which exceed the expertise of traditional planning teams, e.g., capacity variability, work team organization, organizational culture, and work process simplification. By expanding the diversity of the participants of the planning team, there is a greater likelihood that a research organization's scientific, organizational, economic, and employees' needs can be meshed in the strategic plan and facility plan. Recent recommendations from facility planners suggest drawing from diverse fields in building multi-disciplinary planning teams: Architecture, engineering, natural science, social psychology, and strategic planning (Gibson,1993). For organizations undergoing significant operational or culture change, the master facility planning team should also include members with expertise in organizational effectiveness, industrial engineering, human resources, and environmental psychology. A recent planning and design project provides an example which illustrates the use of an expanded multi-disciplinary team engaged in planning laboratory renovations for a research organization undergoing programmatic re-direction. The purpose of the proposed poster session is to present a multi-disciplinary master facility planning process linked to an organization's strategic planning process or organizational strategies.

7902 (UCRL-JC–113553) **A global overview of risk management of the DOE complex.** Alesso, H.P.; Majumdar, K.C. Lawrence Livermore National Lab., CA (United States). 10 Oct 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940312–20: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001634. Source: OSTI; NTIS; INIS; GPO Dep.

No endeavor is risk-fire and as we realize the inherent risks in society, our only viable solution is to manage the risk. Application of an integrated risk management program of a large technological system like the DOE complex is a difficult, task; but it is the only rational means to optimize the risk-benefit equation. An effective risk management culture-within the DOE complex will in the long run, ensure a consistent response to mitigate identified risks. An effective risk management program provides responsible administrative planning and logical application of the best technical analyses. It requires the involvement of all personnel. Our objective in this paper is to point out broad perspectives that raise concerns about future DOE ask management issues and to suggest some possible remedies.

7903 (UCRL-JC–115243) **Risk management at Lawrence Livermore National Laboratory.** Cummings, G.E.; Strait, R.S. Lawrence Livermore National Lab., CA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract W-7405-ENG-48. (CONF-940312–45: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94003369. Source: OSTI; NTIS; INIS; GPO Dep.

Managing risks at a large national laboratory presents a unique set of challenges. These challenges include the management of a broad diversity of activities, the need to balance research flexibility against management control, and a plethora of requirements flowing from regulatory and oversight bodies. This paper will present the experiences of Lawrence Livermore National Laboratory (LLNL) in risk management and in dealing with these challenges. While general risk management has been practiced successfully by all levels of Laboratory management, this paper will focus on the Laboratory's use of probabilistic safety assessment and prioritization techniques and the integration of these techniques into Laboratory operations.

7904 (UCRL-JC–115244) **Risk-based prioritization: A comparison of approaches.** Strait, R.S. Lawrence Livermore National Lab., CA (United States). Oct 1993. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940312–47: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94003368. Source: OSTI; NTIS; GPO Dep.

the use of analytical techniques for risk-based prioritization, both quantitative and non-quantitative, is becoming much more wide spread and organizations are tailoring analytical techniques for risk management to their particular needs. This has led to the use of different techniques for different applications within the same organization, and correspondingly, the need for management to reconcile the process and results of different risk-based prioritization approaches. Different risk-based prioritization methods may be used prioritize different types of activities, but eventually these prioritizations may need to be integrated to allocate organizational resources at a higher level or to develop an overall organizational budget. This paper focuses on comparing and contrasting the different risk-based approaches. The objective is to help management understand the different approaches, choose the best approach for their needs, and reconcile different approaches.

9902 Mathematics and Computers

Refer also to citation(s) 6158, 6182, 6286, 6311, 6312, 6484, 6546, 6592, 6627, 6646, 6649, 6657, 6675, 6676, 6681, 6683, 6685, 6686, 6687, 6705, 6707, 6715, 6725, 6726, 6731, 6733, 6735, 6736, 6737, 6738, 6741, 6748, 6766, 6816, 6827, 6847, 6864, 6964, 7091, 7138, 7140, 7148, 7149, 7151, 7152, 7154, 7160, 7178, 7179, 7181, 7186, 7200, 7295, 7320, 7343, 7349, 7359, 7370, 7375, 7379, 7380, 7392, 7403, 7404, 7410, 7422, 7424, 7473, 7495, 7506, 7518, 7520, 7521, 7522, 7546, 7740, 7900, 7954, 7955

7905 (ANL–93/40) **Using a transfer function to describe the load-balancing problem.** Conley, A.J. Argonne National Lab., IL (United States). Nov 1993. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE94004218. Source: OSTI; NTIS; GPO Dep.

The dynamic load-balancing problem for mesh-connected parallel computers can be clearly described by introducing a function that identifies how much work is to be transmitted between neighboring processors. This function is a solution to an elliptic problem for which a wealth of knowledge exists. The nonuniqueness of the solution to the load-balancing problem is made explicit.

7906 (ANL/MCS/CP–81643) **The PRISM project: Infrastructure and algorithms for parallel eigensolvers.** Bischof, C. (Argonne National Lab., IL (United States)); Sun, X.; Huss-Lederman, S.; Tsao, A. Argonne National Lab., IL (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-31109-ENG-38. DM28E04120. (CONF-9310220–4: Institute of Electrical and Electronic Engineers (IEEE) meeting on scalable parallel libraries, Starkville, MS (United States), 6-8 Oct 1993). Order Number DE94005125. Source: OSTI; NTIS; GPO Dep.

The goal of the PRISM project is the development of infrastructure and algorithms for the parallel solution of eigenvalue problems. We are currently investigating a complete eigensolver based on the Invariant Subspace Decomposition Algorithm for dense symmetric matrices (SYISDA). After briefly reviewing the SYISDA approach, we discuss the algorithmic highlights of a distributed-memory implementation of an eigensolver based on this approach. These include a fast matrix-matrix multiplication algorithm, a new approach to parallel band reduction and tridiagonalization, and a harness for coordinating the divide-and-conquer parallelism in the problem. We also present performance results of these kernels as well as the overall SYISDA implementation on the Intel Touchstone Delta prototype and the IBM SP/1.

7907 (CEA-N–2734) **Oceanic circulation code on connection machine.** Vitart, F. CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France). 1993. 23p. (In French). Order Number DE94728750. Source: OSTI; NTIS (US Sales Only).

This paper describes a OPA7 computer code used for modelling global climate. Global climate model is obtained by coupling ocean model with atmosphere model. In the present OPA7 code, the equations used are Navier-Stokes equations and Dirichlet boundary conditions.

7908 (DOE/ER/25053–T2) **Applied analysis/computational mathematics: Final report 1993.** Lax, P.; Berger, M. New York Univ., NY (United States). Courant Inst. of Mathematical Sciences. Dec 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER25053. Order Number DE94005133. Source: OSTI; NTIS; GPO Dep.

This is the final report for the Courant Mathematics and Computing Laboratory (CMCL) research program for the years 1991–1993. Our research efforts encompass the formulation of physical problems in terms of mathematical models (both old and new), the mathematical analysis of such models, and their numerical resolution. This last step involves the development and implementation of efficient methods for large scale computation. Our analytic and numerical work often go hand in hand; new theoretical approaches often have numerical counterparts, while numerical experimentation often suggests avenues for analytical investigation.

7909 (DOE/ER/25100–2) **Research on primal-dual interior point algorithms for mathematical programming: Final technical report, August 1991–August 1993.** Zhang, Yin. Maryland Univ., Baltimore, MD (United States). Sep 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-91ER25100. Order Number DE94003982. Source: OSTI; NTIS; GPO Dep.

Today interior-point methods of choice for general linear programming are primal-dual infeasible interior-point algorithms. There is a big gap between theoretical algorithms and practical algorithms. Major goals of the project were to narrow the gaps between theory and practice of primal-dual interior-point methods. The PI (principal investigator) played a leading role in joint work with Richard Tapia on constructing the first superlinear and polynomial primal-dual algorithm. PI's recent work on infeasible interior-point methods established the first polynomial result for today's interior-point methods of device. More recently, PI established polynomial complexities for Mehrotra-type predictor-corrector methods which have been widely regarded today as the most practically efficient methods. This work has laid a solid theoretical foundation for these methods.

7910 (DOE/ER/25118–1) **System Software and Tools for High Performance Computing Environments: A report on the findings of the Pasadena Workshop, April 14–16, 1992.** Sterling, T. (Universities Space Research Association, Washington, DC (United States)); Messina, P.; Chen, M. Jet Propulsion Lab., Pasadena, CA (United States). 1 Apr 1993. 223p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States);Department of Defense, Washington, DC (United States);National Science Foundation, Washington, DC (United States);National Oce DOE

Contract AI02-92ER25118. (JPL-PUBL–93-15). Order Number DE94003918. Source: OSTI; NTIS; GPO Dep.

The Pasadena Workshop on System Software and Tools for High Performance Computing Environments was held at the Jet Propulsion Laboratory from April 14 through April 16, 1992. The workshop was sponsored by a number of Federal agencies committed to the advancement of high performance computing (HPC) both as a means to advance their respective missions and as a national resource to enhance American productivity and competitiveness. Over a hundred experts in related fields from industry, academia, and government were invited to participate in this effort to assess the current status of software technology in support of HPC systems. The overall objectives of the workshop were to understand the requirements and current limitations of HPC software technology and to contribute to a basis for establishing new directions in research and development for software technology in HPC environments. This report includes reports written by the participants of the workshop's seven working groups. Materials presented at the workshop are reproduced in appendices. Additional chapters summarize the findings and analyze their implications for future directions in HPC software technology development.

7911 (DOE/ER/25137–1) **Center for computation and visualization of geometric structures: [Annual], Progress report.** Minnesota Univ., Minneapolis, MN (United States). 12 Feb 1993. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-92ER25137. Order Number DE94001882. Source: OSTI; NTIS; GPO Dep.

The mission of the Center is to establish a unified environment promoting research, education, and software and tool development. The work is centered on computing, interpreted in a broad sense to include the relevant theory, development of algorithms, and actual implementation. The research aspects of the Center are focused on geometry; correspondingly the computational aspects are focused on three (and higher) dimensional visualization. The educational aspects are likewise centered on computing and focused on geometry. A broader term than education is 'communication' which encompasses the challenge of explaining to the world current research in mathematics, and specifically geometry.

7912 (DOE/FTR–93018766) **Participation in the semi-annual meeting of Cray computing systems: Foreign trip report, April 20–27, 1991.** Ralph, W.D. Sandia National Labs., Albuquerque, NM (United States). 6 May 1991. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Order Number DE93018766. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Since 1982, Cray supercomputers have been an important tool for the scientists working on the mission of Sandia National Laboratories. Security features of the operating system software supported by Cray Research, Inc., must meet the standards of Sandia National Labs and the Department of Energy in order to protect sensitive data from compromise. In adapting UNICOS to the Sandia environment, several problems were encountered with software released by Cray Research. One reason for attendance at this conference was to share experiences with other supercomputer users who may be undertaking simiiar efforts. Another reason was to provide Cray Research with feedback on effectiveness of their software to meet security standards of Sandia Labs. In addition, Cray's planned software evolution, particularly in networking and security, was a major topic of discussion of interest to Sandia Labs.

7913 (ECN-C–93-062) **Experience with the Common KADS WB.** Bogaard, D.D. Netherlands Energy Research Foundation (ECN), Petten (Netherlands). Oct 1993. 35p. Order Number DE94729856. Source: OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands).

A student's report.

The purpose of this report was for the author to get acquainted with the Common KADS methodology and to elaborate a knowledge model. The author evaluated in particular the Life Cycle Model (LCM) layer of the Common KADS workbench (WB) and wrote down all the bugs, encountered while working with KADS-WB. The elaboration of the knowledge model resulted in several task decompositions, inference structures, and a project that was introduced into the WB. In chapter Common KADS is introduced, based on existing literature. In chapter two the experiences of the author with the Life Cycle Model, which is part of the WB, are outlined. In chapter three the practical use of the WB is described. In section 3.1 a summary is given of an article by the author's supervisor J.R. Balder about experiences with KADS using reverse knowledge based systems engineering. Also Figaro, a system used by 'Electricite de France' for assessing the reliability of electricity generating systems, is discussed. Figaro is an existing system that has to be reverse engineered into a Common KADS set of models. Often used concepts in this process are task decompositions and inference structures, which will be presented in section 3.2. Section 3.3 is about the author's experiences with introducing these task decompositions into the WB. 25 figs., 1 appendix, 9 refs.

7914 (ESTSC–000597IBMPC02) **GWSCREEN2.02: Groundwater Screen.** Rood, A.S. (EG and G Idaho Inc., Idaho Falls, ID (United States)). EG and G Idaho, Inc., Idaho Falls, ID (United States). 1 Aug 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Source: ESTSC.

Description: IBM PC; MS DOS 5.0; FORTRAN77; 1 3.5 DISKETTE. The default input file name is GWSCREEN.PAR and the default output file name is GWSCREEN.OUT. The user may use any MS DOS legal file name (Maximum of 12 characters). In the sample problems, the following conventions were used. filename.PAR Input file that contains values to the GWSCREEN parameters and variables. filename.OUT Output file for the maximum concentration calculation and limiting soil of pond effluent concentration. filename.LST Output file for concentration verses time output.

GWSCREEN was developed for assessment of the groundwater pathway from leaching of radioactive and non radioactive substances from surface or buried sources and release to percolation ponds. The code calculates the limiting soil concentration or effluent release concentration such that, after leaching and transport to the aquifer, regulatory contaminant levels in groundwater are not exceeded. The code uses a masss conservation approach to model three processes: Contaminant release from a source volume, contaminant transport in the unsaturated zone, and contaminant transport in the saturated zone. The source model considers the sorptive properties and solubility of the contaminant. Transport in the unsaturated zone is described by a plug flow model. Transport in the saturated zone is calculated with a semi-analytical solution to the advection dispersion equation in groundwater. Concentration as a function of time at a user specified receptor point and maximum concentration averaged over the exposure interval are also calculated. In addition, the code calculates transport and impacts of radioactive progeny. Input to GWSCREEN is through one, free format ASCII file. This code was designed for assessment and screening of the groundwater pathway when field data is limited. It was not intended to be a predictive tool.

7915 (ESTSC–000635IBMPC00) **LPDSERVICES: An RFC 1179 Compatible Remote Print Server for Windows 3.1.** Brooks, D.L. (EG and G Idaho Inc., Idaho Falls, ID (United States)). EG and G Idaho, Inc., Idaho Falls, ID (United States). 15 Mar 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Source: ESTSC.

Description: IBM PC; MICROSOFT OR IBM DOS THAT SUPPORMICROSOFT C/C++ VERSION 7.0; 1 3.5 DISKETTE. The print manager and spooler use the directory 'spool nlpd' for storage of files. The print manager uses the file 'seqno' to store a unique sequence number. The print manager and spooler use the file 'translat' to associate remote filenames with local DOS filenames. Files that start with 'CF*' are control files. They are transmitted as part of the protocol, and written by the print manager. The spooler reads the control file, uses information in it to print data files, and then deletes the control file. Files that start with 'DF*' are data files. They are also transmitted as part of the protocol, and written by the print manager. These files are identified in the control file. The spooler prints the data file then deletes it.

Internet RFC 1179 describes the protocol to be used for printing files on a remote printer in a TCP/IP network. The protocol is client/server, meaning that the client initiates the print request, and

the server recieves the request and performs the actual printing locally. This protocol has been in long use on Unix systems derived from the Berkeley Software Distribution, such as DEC's Ultrix and Sun's SunOS. LPD Services implements the server portion of this protocol. It handles both the network communication and conformance with the protocol, and printing using the Microsoft Windows device independent printing interface.

7916 (ESTSC–000644AL00000) **DELTAE: Design Environment for Low-Amplitude Thermoacoustic Engines.** Ward, W.C (Los Alamos National Lab., NM (United States)); Swift, G.W. Los Alamos National Lab., NM (United States). 1 Nov 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Source: ESTSC.

Description: APPLE MACINTOSH; Off the Shelf; FORTRAN IV; 1 3.5 Diskette.

In thermoacoustic engines and refrigerators, and in many simple acoustic systems, a one dimensional wave equation determines the spatial dependence of the acoustic pressure and velocity. DELTAE numerically integrates such wave equations in the acoustic approximation, in gases or liquids, in user-defined geometries. Boundary conditions can include conventional acoustic boundary conditions of geometry and impedance, as well as temperature and thermal power in thermoacoustic systems. DELTAE can be used easily for apparatus ranging from simple duct networks and resonators to thermoacoustic engines refrigerators and combinations thereof. It can predict how a given apparatus will perform, or can allow the user to design an apparatus to achieve desired performance. DELTAE views systems as a series of segments; twenty segment types are supported. The purely acoustic segments include ducts and cones, and lumped impedances including compliances, series impedances, and endcaps. Electroacoustics tranducer segments can be defined using either frequency-independent coefficients or the conventional parameters of loudspeaker-style drivers: mass, spring constant, magnetic field strength, etc. Tranducers can be current driven, voltage driven, or connected to an electrical load impedance. Thermoacoustic segment geometries include parallel plates, circular and rectangular pores, and pin arrays. Side branches can be defined with fixed impedances, frequency-dependent radiation impedances, or as an auxiliary series of segments of any types. The user can select working fluids from among air, helium, neon, argon, hydrogen, deuterium, carbon dioxide, nitrogen, helium-argon mixtures, helium-xenon mixtures, liquid sodium, and eutectic sodium-potassium. Additional fluids and solids can be defined by the user.

7917 (ESTSC/NRC/R–000098C017600) **BFR: Common Cause Failure Data Analysis.** Atwood, C.L. (EG and G Idaho Inc., Idaho Falls, ID (United States)). EG and G Idaho, Inc., Idaho Falls, ID (United States). 1 Feb 1983. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research. (NESC–9864). Source: ESTSC.

Description: CDC CYBER176; NOS/BE 1.4; FORTRAN IV (95%) and COMPASS (5%); 1 Mag Tape.

BFR uses the binomial failure rate model to estimate the rate of simultaneous failures of similar components. Data consists of recorded single and multiple failures. Either Bayesian or non-Bayesian methods can be employed to find point estimates and interval estimates of the quantities of interest, including the rate at which a specific set of k components fails simultaneously, and the rate at which at least k out of m components fail simultaneously. These rates can be used directly in fault trees, or for calculating probabilities. BFR makes use of subroutines from the proprietary IMSL library; plots, used only for Bayesian regions when the causes of single failures are not identifiable, are produced by the proprietary DISSPLA graphics package. These routines are not included. Typical run time is 80 CP seconds; however, the time varies greatly, depending on the complexity of the data, and about twice as much time is required if the compiler OPT=0, rather than OPT=2 option, is used. An auxiliary program, PTEST, used to check the goodness of fit between the model and data following BFR execution, is included.

7918 (ESTSC/NRC/R–000316IBMPC00) **PHAZE: Parametric Hazard Function Estimation.** Atwood, C.L. (EG and G Idaho Inc., Idaho Falls (United States)). EG and G Idaho, Inc., Idaho Falls, ID (United States). 1 Jul 1990. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research. (NESC–1147). Source: ESTSC.

Description: IBM PC; DOS 3.0 or higher; FORTRAN 77; 1 3.5 Diskette. PHAZE should be portable to other computers by changing the machine-dependent constants in the BLOCK DATA subroutine in the FROZEN1.FOR file.

Phaze performs statistical inference calculations on a hazard function (also called a failure rate or intensity function) based on reported failure times of components that are repaired and restored to service. Three parametric models are allowed: the exponential, linear, and Weibull hazard models. The inference includes estimation (maximum likelihood estimators and confidence regions) of the parameters and of the hazard function itself, testing of hypotheses such as increasing failure rate, and checking of the model assumptions.

7919 (ESTSC/NRC/R–000322I037000) **NUTRAN: Long-Term Repository Safety Analysis.** Koplik, C.M. (Analytic Sciences Corp., Reading, MA (United States)); Nalbandian, J.Y.; Scott, J.I. Analytic Sciences Corp., Reading, MA (United States). 1 Jun 1983. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Material Safety and Safeguards. (NESC–9888). Source: ESTSC.

Description: IBM370; OS/VS1 (IBM370), MVS/XA (IBM3070FORTRAN IV (50%) and PL/I (50%); 1 Mag Tape. Well concentration calculations require the use of the proprietary IMSL mathematical subroutine library, and plot output is produced using the proprietary ISSCO graphics software, DISSPLA. Neither of these software packages is supplied. Alternatives to the IMSL routines EIGRF, LINV2F, AND MMBSKO are included for those users without acess to the IMSL library.

NUTRAN is a system of four computer programs for calculating the dose to humans from radionuclides carried out of deep geologic nuclear waste repositories by ground water. NUTRAN is composed of the FORTRAN programs ORIGEN1 and BIODOSE and the PL/I programs WASTE and PLOT. ORIGEN1, developed by Oak Ridge National Laboratory, generates an inventory of radionuclides as a function of time; BIODOSE computes the doses to humans which result from any releases of radioactivity into the biosphere. WASTE models the release of radionuclides from a repository and their transport in the subsurface, and PLOT combines the results of BIODOSE and WASTE dose per MWe-yr released and releases in units of MWe-yr of waste to obtain doses and generate dose plots. The ORIGEN1 program developed by ORNL is not included. The NUTRAN model incorporates the following features: refilling of the repository cavity with water; leaching of the waste matrix; dissolution of the radioactive elements in the waste; transport of waste by ground water through the repository, surrounding strata, and adjacent aquifers; withdrawal of contaminated ground water through wells; transport of waste in surface waters and associated ecosystems; and human exposure and dose mechanisms.

7920 (ESTSC/NRC/R–000372IBMPC00) **LAS CRUCES DATABASE: Las Cruces Trench Site Database, Vadose Model.** Hills, R. (New Mexico State University, Las Cruces, NM (United States)); Wirenga, P.J. New Mexico State Univ., Las Cruces, NM (United States). 1 Sep 1990. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research. (NESC–1140). Source: ESTSC.

Description: IBM PC; Machine Dependent; FORTRAN; 2 5.25 Diskettes. The IREADME.TXT file contains documentation describing the contents and format of the database files.

The LAS CRUCES TRENCH SITE DATABASE includes raw and processed experimental data obtained from the vadose zone model validation experiments performed on the New Mexico State Ranch northeast of Las Cruces, New Mexico. Included are data characterizing the unsaturated hydraulic properties for the experimental site and dynamic data, such as water contents, tensions, and solute concentrations, obtained during two infiltration redistribution experiments. At the site, a 26.4m long, 4.5m wide, and 5 mile deep trench was constructed in undisturbed soil. During construction a total of 594 disturbed soil samples and 594 associated soil cores were taken from 9 distinct soil layers identified on the north wall. Samples were also taken from three vertical transects on this wall.

Data included in the database are sample locations, a description of the 9 soil layers, bore hole saturated hydraulic conductivities and outflow data, laboratory saturated hydraulic conductivities, soil water retention data, particle size distribution data, bulk density data, parameters used to fit the van Genuchten equation to the water retention data, and estimated van Genuchten parameters for each layer and the entire site. Data obtained from two experiments designed to provide data for testing deterministic and stochastic models of vadose zone flow and transport are also included.

7921 (INIS-mf–13741) **Computer automation and artificial intelligence.** Husnain, S.B. Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). 1992. 12p. (CONF-9204276–: Seminar on research and development in support of technology with military applications, Karachi (Pakistan), 29 Apr 1992). Order Number DE94611058. Source: OSTI; NTIS (US Sales Only); INIS.

Rapid advances in computing, resulting from micro chip revolution has increased its application manifold particularly for computer automation. Yet the level of automation available, has limited its application to more complex and dynamic systems which require an intelligent computer control. In this paper a review of Artificial intelligence techniques used to augment automation is presented. The current sequential processing approach usually adopted in artificial intelligence has succeeded in emulating the symbolic processing part of intelligence, but the processing power required to get more elusive aspects of intelligence leads towards parallel processing. An overview of parallel processing with emphasis on transputer is also provided. A Fuzzy knowledge based controller for amination drug delivery in muscle relaxant anesthesia on transputer is described. 4 figs. (author).

7922 (IS-T–1673) **Performance analysis of memory hierachies in high performance systems.** Yogesh, A. Ames Lab., IA (United States). Jul 1993. 53p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-82. Order Number DE94005549. Source: OSTI; NTIS; GPO Dep.

This thesis studies memory bandwidth as a performance predictor of programs. The focus of this work is on computationally intensive programs. These programs are the most likely to access large amounts of data, stressing the memory system. Computationally intensive programs are also likely to use highly optimizing compilers to produce the fastest executables possible. Methods to reduce the amount of data traffic by increasing the average number of references to each item while it resides in the cache are explored. Increasing the average number of references to each cache item reduces the number of memory requests. Chapter 2 describes the DLX architecture. This is the architecture on which all the experiments were performed. Chapter 3 studies memory moves as a performance predictor for a group of application programs. Chapter 4 introduces a model to study the performance of programs in the presence of memory hierarchies. Chapter 5 explores some compiler optimizations that can help increase the references to each item while it resides in the cache.

7923 (JINR-R–11-92-409) **Goodness-of-fit criteria based on test statistics $\omega_n^3 = n^{3/2} \int_{-\infty}^{\infty} [S_n(x) - F(x)]^3 dF(x)$: Investigation of power of one-sided criterion for large n.** Zrelov, P.V.; Ivanov, V.V. Joint Inst. for Nuclear Research, Dubna (Russian Federation). Lab. of Computing Techniques and Automation. 1992. 22p. (In Russian). Order Number DE94611059. Source: OSTI; NTIS (US Sales Only); INIS.

The main properties of new integral nonparametric goodness-of-fit criterion ω_n^3 for large emperical samples sizes are considered. Its comparison with familiar ω_n^2 criterion and with Watson's criterion U-bar (connected with another integral criterion ω_n^1) in frames of Chapman's approach for n=50, 200 and 1000 was performed. For alternative hypotheses, minimizing the power, an advantage of the ω_n^3 in a sufficient broad range of significance level a and, what is specially important for practical applications, for small values was shown. It was also shown that for hypotheses, maximizing the power, the Watson's criterion has a slight advantage over ω_n^3 criterion. The analytical expressions allowing to evaluate the power of ω_n^3 criterion for arbitrary one-sided alternative hypotheses are presented. 9 refs.; 5 figs.

7924 (KAERI/AR–370/93) **Review of activities for evaluating basic nuclear data.** Min, Byung Joo (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)). Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). May 1993. 58p. (In Korean). Order Number DE94611060. Source: OSTI; NTIS (US Sales Only); INIS.

For the development of an advanced reactor and associated as well as the management of radwastes, new basic nuclear data in the area of emitting high energy are required. Since these basic elements are used for the correct calculation of nuclear system applications, a research for the nuclear data evaluation should be accomplished. Advanced industrialised countries have been invested in manpower and financial constraints for long time, and they have developed and used the basic nuclear data. We are still relying on other countries for evaluated nuclear data. Only an activity for evaluated nuclear data compilation has been carried out for the last 10 years. Since a lot of qualified manpower are required for nuclear data evaluation, the collaboration with advanced countries will be needed. (Author).

7925 (KAERI/TR–277/92) **The development of a statistical report software for computer system usages.** Lee, Young Jai (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Lee, Hae Cho; Park, Jeong Seok; Sohn, Jae Min; Park, Bong Sik; Park, Sun Hee; Hwang, In Ah; Park, Soo Jin. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jun 1992. 172p. (In Korean). Order Number DE94611061. Source: OSTI; NTIS (US Sales Only); INIS.

In this report, we describe the data base system developed for various statistical analysis of KAERI computer system usages. In keeping abreast with the rapid growth of information society, many devices for handling information are developed and purchased. At KAERI's computer operation facility, several information processing devices have been installed and are under operation now. It has been found very difficult to draw up a long term plan for computer operation management due to the lack of accumulated operation history data. Combined charge information is generated and transferred to the VAX 6320 system. The data base system on the VAX 6320 was implemented using the ORACLE RDBMS software. The computing services history data was all processed and collected into the data base for the fiscal years 1990 and 1991. It is expected that this data base will be used in many convenient ways in the future. (Author).

7926 (KAERI/TR–278/92) **An analysis of file system and installation of the file management system for NOS operating system.** Lee, Young Jai (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Park, Sun Hee; Hwang, In Ah; Kim, Hee Kyung. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jun 1992. 65p. (In Korean). Order Number DE94611062. Source: OSTI; NTIS (US Sales Only); INIS.

In this technical report, we analyze NOS file structure for Cyber 170-875 and Cyber 960-31 computer system. We also describe functions, procedure and how-to-operate and how-to-use of VDS. VDS is used to manage large files effectively for Cyber computer system. The purpose of the VDS installation is to increase the virtual disk storage by utilizing magnetic tape, to assist the users of the computer system in managing their files, and to enhance the performance of KAERI Cyber computer system. (Author).

7927 (KAERI/TR–353/93) **ONED90: 1-dimensional diffusion code.** Zee, Sung Kyun (Korea Atomic Energy Res. Inst., Taejon (Korea, Republic of)); Chang, Jong Hwa; Kim, Si Yong; Lee, Sang Hoon; Lee, Ki Bog; Noh, Jae Man. Korea Atomic Energy Research Inst., Daeduk (Korea, Republic of). Jun 1993. 109p. (In Korean). Order Number DE94611063. Source: OSTI; NTIS (US Sales Only); INIS.

The validity of ONED90(1-Dimensional 2-Group Diffusion Code) for nuclear design and plant reactor simulation has been confirmed through comparisons of some calculational results from ONED90 with current design values and measured data. Main methology of ONED90 including user's manual has been described in detail. (Author).

7928 (LA-UR–92-1507) **Compression of fingerprint data using the wavelet vector quantization image compression algorithm: 1992 progress report.** Bradley, J.N.; Brislawn, C.M. Los Alamos National Lab., NM (United States). 11 Apr 1992. 33p. Sponsored by Department of the Treasury, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94004996. Source: OSTI; NTIS; GPO Dep.

This report describes the development of a Wavelet Vector Quantization (WVQ) image compression algorithm for fingerprint raster files. The pertinent work was performed at Los Alamos National Laboratory for the Federal Bureau of Investigation. This document describes a previously-sent package of C-language source code, referred to as LAFPC, that performs the WVQ fingerprint compression and decompression tasks. The particulars of the WVQ algorithm and the associated design procedure are detailed elsewhere; the purpose of this document is to report the results of the design algorithm for the fingerprint application and to delineate the implementation issues that are incorporated in LAFPC. Special attention is paid to the computation of the wavelet transform, the fast search algorithm used for the VQ encoding, and the entropy coding procedure used in the transmission of the source symbols.

7929 (LA-UR–93-3461) **Is probability of frequency too narrow?.** Martz, H.F. Los Alamos National Lab., NM (United States). [1993]. 9p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940312–12: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94000687. Source: OSTI; NTIS; INIS; GPO Dep.

Modern methods of statistical data analysis, such as empirical and hierarchical Bayesian methods, should find increasing use in future Probabilistic Risk Assessment (PRA) applications. In addition, there will be a more formalized use of expert judgment in future PRAs. These methods require an extension of the probabilistic framework of PRA, in particular, the popular notion of probability of frequency, to consideration of frequency of frequency, frequency of probability, and probability of probability. The genesis, interpretation, and examples of these three extended notions are discussed.

7930 (LA-UR–93-3914) **A survey of open problems in symplectic integration.** McLachlan, R.I. (Univ. of Colorado, Boulder, CO (United States)); Scovel, C. Los Alamos National Lab., NM (United States). 15 Oct 1993. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9310235–1: Integration algorithms for classical mechanics, Ontario (Canada), 14-27 Oct 1993). Order Number DE94003966. Source: OSTI; NTIS; GPO Dep.

In the past few years there has been a substantial amount of research on symplectic integration. The subject is only part of a program concerned with numerically preserving a system's inherent geometrical structures. Volume preservation, reversibility, local conservation laws for elliptic equations, and systems with integral invariants are but a few examples of such invariant structures. In many cases one requires a numerical method to stay in the smallest possible appropriate group of phase space maps. It is not the authors' opinion that symplecticity, for example, automatically makes a numerical method superior to all others, but it is their opinion that it should be taken seriously and that a conscious, informed decision be made in that regard. The authors present here a survey of open problems in symplectic integration, including other problems from the larger program. This is not intended as a review of symplectic integration and is naturally derived from the authors' own research interests. At present, this survey is incomplete, but the authors hope the help of the colleagues to be able to include in the proceedings of this conference a more comprehensive survey. Many of the problems mentioned here call for numerical experimentation, some for application of suggested but untested methods, some for new methods, and some for theorems, Some envisage large research programs.

7931 (LA-UR–93-4102) **Adaptive optimization and control using neural networks.** Mead, W.C.; Brown, S.K.; Jones, R.D.; Bowling, P.S.; Barnes, C.W. Los Alamos National Lab., NM (United States). 22 Oct 1993. 18p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-931023–9: International conference on accelerator and large experimental control systems, Berlin (Germany), 18-22 Oct 1993). Order Number DE94003941. Source: OSTI; NTIS; GPO Dep.

Recent work has demonstrated the ability of neural-network-based controllers to optimize and control machines with complex, non-linear, relatively unknown control spaces. We present a brief overview of neural networks via a taxonomy illustrating some capabilities of different kinds of neural networks. We present some successful control examples, particularly the optimization and control of a small-angle negative ion source.

7932 (LA-UR–93-4251) **Estimators for the Cauchy distribution.** Hanson, K.M.; Wolf, D.R. Los Alamos National Lab., NM (United States). [1993]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9308205–1: 13. MAXENT workshop, Santa Barbara, CA (United States), 1-3 Aug 1993). Order Number DE94004990. Source: OSTI; NTIS; GPO Dep.

We discuss the properties of various estimators of the central position of the Cauchy distribution. The performance of these estimators is evaluated for a set of simulated experiments. Estimators based on the maximum and mean of the posterior probability density function are empirically found to be well behaved when more than two measurements are available. On the contrary, because of the infinite variance of the Cauchy distribution, the average of the measured positions is an extremely poor estimator of the location of the source. However, the median of the measured positions is well behaved. The rms errors for the various estimators are compared to the Fisher-Cramer-Rao lower bound. We find that the square root of the variance of the posterior density function is predictive of the rms error in the mean posterior estimator.

7933 (LBL–33808) **Analytic rendering of curvilinear volume data.** Bethel, W. Lawrence Berkeley Lab., CA (United States). Mar 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE94004934. Source: OSTI; NTIS; GPO Dep.

A technique is presented for analytically rendering volume data from curvilinear grids. The method employs analytic techniques for manipulating and rendering curvilinear voxels. A curvilinear voxel is represented using a cubic triparametric solid formulation. The control points defining the cubic triparametric voxel are computed from the original curvilinear grid using the Catmull-Rom formulation, and subsequently rendered using a three-dimensional forward difference operator. The primary benefit from using such a representation is the fact the voxel shape and data values are C1-continuous across voxel boundaries. The issue of voxel opacity, both at the sub-voxel and super-voxel levels, is investigated. The use of both tricubic representation and rendering, along with the new approach to managing voxel opacity, results in images which are markedly different from those presented in previous work.

7934 (LBL–34819) **Interface Configuration Experiment: Preliminary results.** Concus, P. (Lawrence Berkeley Lab., CA (United States)); Finn, R.; Weislogel, M. Lawrence Berkeley Lab., CA (United States). Sep 1993. 16p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098. GRANT NAG3-1143; GRANT DMS89-02831. (CONF-9309279–1: Joint L+1 science review for USML-1 and USMP-1, Huntsville, AL (United States), 22-24 Sep 1993). Order Number DE94003413. Source: OSTI; NTIS; GPO Dep.

The Interface Configuration Experiment (ICE) was carried out on USML-1 to investigate liquid-gas interfaces in certain rotationally-symmetric containers having prescribed, mathematically derived shapes. These containers have the property that they admit an entire continuum of distinct equilibrium rotationally-symmetric interfaces for a given liquid volume and contact angle. Furthermore, it can be shown that none of these interfaces can be stable. It was found, after the containers were filled in orbit, that an initial equilibrium interface from the symmetric continuum reoriented, when perturbed, to a stable interface that was not rotationally symmetric, in accordance with the mathematical theory.

7935 (ORNL/TM–12440) **Cryptosystems based on chaotic dynamics.** McNees, R.A.; Protopopescu, V.; Santoro, R.T.; Tolliver, J.S. Oak Ridge National Lab., TN (United States). Aug 1993. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94004256. Source: OSTI; NTIS; GPO Dep.

An encryption scheme based on chaotic dynamics is presented. This scheme makes use of the efficient and reproducible generation of cryptographically secure pseudo random numbers from chaotic maps. The result is a system which encrypts quickly and possesses a large keyspace, even in small precision implementations. This system offers an excellent solution to several problems including the dissemination of key material, over the air rekeying, and other situations requiring the secure management of information.

7936 (PNL-SA–21769) **High performance computing in chemistry and massively parallel computers: A simple transition?.** Kendall, R.A. Pacific Northwest Lab., Richland, WA (United States). Mar 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9303248–1: 1993 Sanible symposia, St. Augustine, FL (United States), 15-19 Mar 1993). Order Number DE94004318. Source: OSTI; NTIS; GPO Dep.

A review of the various problems facing any software developer targeting massively parallel processing (MPP) systems is presented. Issues specific to computational chemistry application software will be also outlined. Computational chemistry software ported to and designed for the Intel Touchstone Delta Supercomputer will be discussed. Recommendations for future directions will also be made.

7937 (PNL-SA–22009) **Emerging human-computer interface (HCI) design guidelines for graphical user interface (GUI).** Bowser, S.E.; Adams, S.M. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 8p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9310100–7: Human Factors and Ergonomics Society meeting, Seattle, WA (United States), 11-15 Oct 1993). Order Number DE94004293. Source: OSTI; NTIS; GPO Dep.

The requirement to establish baseline style references for Graphical User Interfaces (GUIs) is recognized. The ability to obtain consensus among user communities has been limited to nonexistent. The authors are part of a team that has developed a generic baseline human-computer interface (HCI) style guide for the U.S. Department of Defense (DoD). The DoD HCI Style Guide has its origin in a style guide developed by the intelligence community and in human factors design guidelines developed for Army tactical command and control systems. The DoD HCI Style Guide is intended to be a baseline style reference for the design of HCIs within DoD. The needs of specific user communities have been addressed by including addenda that expand on the baseline and address focus areas of interest. The conclusion is that an overall or general style guide should be adopted for GUIs with allowance for specialized user group requirements and additions. The anticipated results would be higher productivity and reduced training and development time.

7938 (PNL-SA–22915) **Frequency-domain transfer-function identification using Chebyshev polynomials.** Johnson, J.M.; Trudnowski, D.J. Pacific Northwest Lab., Richland, WA (United States). Dec 1993. 3p. Sponsored by USDOE, Washington, DC (United States);Northwest Organization for College and University Science (United States). DOE Contract AC06-76RL01830 ; FG06-89ER75522. (CONF-931233–3: 32. Institute of Electrical and Electronic Engineers (IEEE) conference on decision and control, San Antonio, TX (United States), Dec 1993). Order Number DE94004777. Source: OSTI; NTIS; GPO Dep.

An approach is proposed for identifying a linear single-input single-output model from the frequency response of a system with unknown order. The approach involves representing the transfer function as the ratio of linearly-combined Chebyshev polynomials and solving an over-determined linear equation set. The method is compared with two other previously proposed techniques and shown to perform very well under noisy data conditions.

7939 (PNL-SA–23116) **Software redesign for usability: A case study.** Sanchez, J.A.; Adickes, M.D. Pacific Northwest Lab., Richland, WA (United States). Oct 1993. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9310100–4: Human Factors and Ergonomics Society meeting, Seattle, WA (United States), 11-15 Oct 1993). Order Number DE94003704. Source: OSTI; NTIS; GPO Dep.

In an ideal software development environment, the use of a programming language such as C allows developers the ability to create an application that matches the requirements and needs of a client. Recent breakthroughs and advances in software design and graphical user interfaces, however, make it much more difficult to justify, from either a cost or time perspective, developing an application completely from scratch using such a language. By using commercial development packages (prototyping development tools), developers are freed from many of the time consuming tasks that would ordinarily be involved in creating an application, and are able instead to concentrate on what should be the two most important areas of an application, what it should do and how it should look. This poster session illustrates the significant benefits that can be achieved by creating an application using a commercial data base package with a graphical user interface developer along with a multidisciplinary team of developers. The primary emphasis of the display focuses on the ability of the developer to incorporate human factors considerations to ensure that the program is both easy to use and easy to change, given additional client inputs and requests.

7940 (SAND–93-0871) **Modeling data throughput on communication networks.** Eldridge, J.M. Sandia National Labs., Albuquerque, NM (United States). Nov 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94005077. Source: OSTI; NTIS; GPO Dep.

New challenges in high performance computing and communications are driving the need for fast, geographically distributed networks. Applications such as modeling physical phenomena, interactive visualization, large data set transfers, and distributed supercomputing require high performance networking [St89][Ra92][Ca92]. One measure of a communication network's performance is the time it takes to complete a task – such as transferring a data file or displaying a graphics image on a remote monitor. Throughput, defined as the ratio of the number of useful data bits transmitted per the time required to transmit those bits, is a useful gauge of how well a communication system meets this performance measure. This paper develops and describes an analytical model of throughput. The model is a tool network designers can use to predict network throughput. It also provides insight into those parts of the network that act as a performance bottleneck.

7941 (SAND–93-2171C) **PUMA: An operating system for massively parallel systems.** Wheat, S.R. (Sandia National Labs., Albuquerque, NM (United States)); Riesen, R.; Maccabe, A.B.; van Dresser, D.W.; Stallcup, T.M. Sandia National Labs., Albuquerque, NM (United States). [1993]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940136–1: 27. Hawaii international conference on system sciences, Maui, HI (United States), 4-7 Jan 1994). Order Number DE94001597. Source: OSTI; NTIS; GPO Dep.

This paper presents an overview of PUMA, (Performance-oriented, User-managed Messaging Architecture), a message passing kernel. Message passing in PUMA is based on portals-an opening in the address space of an application process. Once an application process has established a portal, other processes can write values into the portal using a simple send operation. Because messages are written directly into the address space of the receiving process, there is no need to buffer messages in the PUMA kernel and later copy them into the applications address space. PUMA consists of two components: The quintessential kernel (Q-Kernel) and the process control thread (PCT) While the PCT provides management decisions, the Q-Kernel controls access and implements the policies specified by the PCT.

7942 (SAND–93-2419C) **Multiple weight stepwise regression.** Atkins, J. (California Univ., Berkeley, CA (United States).

Dept. of Statistics); Campbell, J. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–29: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001602. Source: OSTI; NTIS; GPO Dep.

In many science and engineering applications, there is an interest in predicting the outputs of a process for given levels of inputs. In order to develop a model, one could run the process (or a simulation of the process) at a number of points (a point would be one run at one set of possible input values) and observe the values of the outputs at those points. There observations can be used to predict the values of the outputs for other values of the inputs. Since the outputs are a function of the inputs, we can generate a surface in the space of possible inputs and outputs. This surface is called a response surface. In some cases, collecting data needed to generate a response surface can e very expensive. Thus, in these cases, there is a powerful incentive to minimize the sample size while building better response surfaces. One such case is the semiconductor equipment manufacturing industry. Semiconductor manufacturing equipment is complex and expensive. Depending upon the type of equipment, the number of control parameters may range from 10 to 30 with perhaps 5 to 10 being important. Since a single run can cost hundreds or thousands of dollars, it is very important to have efficient methods for building response surfaces. A current approach to this problem is to do the experiment in two stages. First, a traditional design (such as fractional factorial) is used to screen variables. After deciding which variables are significant, additional runs of the experiment are conducted. The original runs and the new runs are used to build a model with the significant variables. However, the original (screening) runs are not as helpful for building the model as some other points might have been. This paper presents a point selection scheme that is more efficient than traditional designs.

7943 (SAND–93-2420C) **Identification of components to optimize improvement in system reliability.** Painton, L. (Carnegie-Mellon Univ., Pittsburgh, PA (United States). Dept. of Engineering and Public Policy); Campbell, J. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940312–22: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001601. Source: OSTI; NTIS; GPO Dep.

The fields of reliability analysis and risk assessment have grown dramatically since the 1970s. There are now bodies of literature and standard practices which cover quantitative aspects of system analysis such as failure rate and repair models, fault and event tree generation, minimal cut sets, classical and Bayesian analysis of reliability, component and system testing techniques, decomposition methods, etc. In spite of the growth in the sophistication of reliability models, however, little has been done to integrate optimization models within a reliability analysis framework. That is, often reliability models focus on characterization of system structure in terms of topology and failure/availability characteristics of components. A number of approaches have been proposed to help identify the components of a system that have the largest influence on overall system reliability. While this may help rank order the components, it does not necessarily help a system design team identify which components they should improve to optimize overall reliability (it may be cheaper and more effective to focus on improving two or three components of smaller importance than one component of larger importance). In this paper, we present an optimization model that identifies the components to be improved to maximize the increase in system MTBF, subject to a fixed budget constraint. A dual formulation of the model is to minimize cost, subject to achieving a certain level of system reliability.

7944 (SAND–93-2595C) **Out of core, out of mind: Practical parallel I/O.** Womble, D.E.; Greenberg, D.S.; Riesen, R.E.; Wheat, S.R. Sandia National Labs., Albuquerque, NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9310220–2: Institute of Electrical and Electronic Engineers (IEEE) meeting on scalable parallel libraries, Starkville, MS (United States), 6-8 Oct 1993). Order Number DE94003107. Source: OSTI; NTIS; GPO Dep.

Parallel computers are becoming more powerful and more complex in response to the demand for computing power by scientists and engineers. Inevitably, new and more complex I/O systems will be developed for these systems. In particular we believe that the I/O system must provide the programmer with the ability to explcitly manage storage (despite the trend toward complex parallel file systems and caching schemes). One method of doing so is to have a partitioned secondary storage in which each processor owns a logical disk. Along with operating system enhancements which allow overheads such as buffer copying to be avoided and libraries to support optimal remapping of data, this sort of I/O system meets the needs of high performance computing.

7945 (SAND–93-2596C) **Communication on the Paragon.** Greenberg, D.; Maccabe, B.; McCurley, K.S.; Riesen, R.; Wheat, S. Sandia National Labs., Albuquerque, NM (United States). 15 Oct 1993. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9310232–2: Intel Super Computer Users Group meeting, St. Louis, MO (United States), 4 Oct 1993). Order Number DE94003103. Source: OSTI; NTIS; GPO Dep.

In this note the authors describe the results of some tests of the message-passing performance of the Intel Paragon. These tests have been carried out under both the Intel-supplied OSF/1 operating system with an NX library, and also under an operating system called SUNMOS (Sandia UNM Operating System). For comparison with the previous generation of Intel machines, they have also included the results on the Intel Touchstone Delta. The source code used for these tests is identical for all systems. As a result of these tests, the authors can conclude that SUNMOS demonstrates that the Intel Paragon hardware is capable of very high bandwidth communication, and that the message coprocessor on Paragon nodes can be used to give quite respectable latencies. Further tuning can be expected to yield even better performance.

7946 (SAND–93-2597C) **Achieving high performance on the Intel Paragon.** Greenberg, D.S.; Maccabe, B.; Riesen, R.; Wheat, S.; Womble, D. Sandia National Labs., Albuquerque, NM (United States). [1993]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9310232–1: Intel Super Computer Users Group meeting, St. Louis, MO (United States), 4 Oct 1993). Order Number DE94003108. Source: OSTI; NTIS; GPO Dep.

When presented with a new supercomputer most users will first ask "How much faster will my applications run?" and then add a fearful "How much effort will it take me to convert to the new machine?" This paper describes some lessons learned at Sandia while asking these questions about the new 1800+ node Intel Paragon. The authors conclude that the operating system is crucial to both achieving high performance and allowing easy conversion from previous parallel implementations to a new machine. Using the Sandia/UNM Operating System (SUNMOS) they were able to port a LU factorization of dense matrices from the nCUBE2 to the Paragon and achieve 92% scaled speed-up on 1024 nodes. Thus on a 44,000 by 44,000 matrix which had required over 10 hours on the previous machine, they completed in less than 1/2 hour at a rate of over 40 GFLOPS. Two keys to achieving such high performance were the small size of SUNMOS (less than 256 kbytes) and the ability to send large messages with very low overhead.

7947 (SAND–93-3807) **Sandia's research network for Supercomputing '93: A demonstration of advanced technologies for building high-performance networks.** Gossage, S.A.; Vahle, M.O. Sandia National Labs., Albuquerque, NM (United States). Dec 1993. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94005319. Source: OSTI; NTIS; GPO Dep.

Supercomputing '93, a high-performance computing and communications conference, was held November 15th through 19th, 1993 in Portland, Oregon. For the past two years, Sandia National Laboratories has used this conference to showcase and focus its

communications and networking endeavors. At the 1993 conference, the results of Sandia's efforts in exploring and utilizing Asynchronous Transfer Mode (ATM) and Synchronous Optical Network (SONET) technologies were vividly demonstrated by building and operating three distinct networks. The networks encompassed a Switched Multimegabit Data Service (SMDS) network running at 44.736 megabits per second, an ATM network running on a SONET circuit at the Optical Carrier (OC) rate of 155.52 megabits per second, and a High Performance Parallel Interface (HIPPI) network running over a 622.08 megabits per second SONET circuit. The SMDS and ATM networks extended from Albuquerque, New Mexico to the showroom floor, while the HIPPI/SONET network extended from Beaverton, Oregon to the showroom floor. This paper documents and describes these networks.

7948 (SRT-ATS–930104) **Scientific Computations section monthly report September 1993.** Buckner, M.R. Westinghouse Savannah River Co., Aiken, SC (United States). 1 Nov 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94004944. Source: OSTI; NTIS; GPO Dep.

This progress report is computational work that is being performed in the areas of thermal analysis, applied statistics, applied physics, and thermal hydraulics.

7949 (UCRL-ID–115099-Rev.1) **Livermore Computing Production Control System, 3.0: Product description: Revision 1.** Wood, R.R. Lawrence Livermore National Lab., CA (United States). Nov 1993. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94005293. Source: OSTI; NTIS; GPO Dep.

The purpose of this document is to introduce and describe the Livermore Computing Production Control System, commonly called the PCS. Resource management is very difficult in typical UNIX and related systems. The weakness involves the allocation, control and delivery of the usage of computer resources. Accounting also is weak, being generally limited to reporting that a user used an amount of time on a process. A process accounting record is made only after the completion of a process and then only if the process does not terminate as a result of a system panic. Resources can only be allocated to users. No cognizance can be taken of organizational structure or projects. Allocations cannot be managed at these levels. Denying service to a user who has access to a machine is crude. Large computing centers frequently have thousands of users working on hundreds of projects. These users and the projects are funded by several organizations with varying ability or willingness to pay for the computer services provided. With only typical UNIX tools, the appropriate delivery of resources to the correct organizations, projects, tasks and users requires continual human intervention. UNIX and related systems have become increasingly more reliable over the past few years. A consequence of this is that resource managers and accountants have been presented with an attendant problem of accurate accounting for resources used. Processes can now run for days or months without terminating. A run-away process or a malicious or uninformed user can use an organization's budgeted resource allocation many times over before an accounting record to that effect is written. If a process's accounting record is not written because of a panic, the computer center is faced with possibly significant financial loss.

7950 (UCRL-JC–115318) **The High Performance Storage System.** Coyne, R.A. (IBM Federal Systems Co., Houston, TX (United States)); Hulen, H.; Watson, R. Lawrence Livermore National Lab., CA (United States). Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-931115–13: Supercomputing conference on high performance computing and communications, Portland, OR (United States), 15-19 Nov 1993). Order Number DE94004351. Source: OSTI; NTIS; GPO Dep.

The National Storage Laboratory (NSL) was organized to develop, demonstrate and commercialize technology for the storage system that will be the future repositories for our national information assets. Within the NSL four Department of Energy laboratories and IBM Federal System Company have pooled their resources to develop an entirely new High Performance Storage System (HPSS). The HPSS project concentrates on scalable parallel storage system for highly parallel computers as well as traditional supercomputers and workstation clusters. Concentrating on meeting the high end of storage system and data management requirements, HPSS is designed using network-connected storage devices to transfer data at rates of 100 million bytes per second and beyond. The resulting products will be portable to many vendor's platforms. The three year project is targeted to be complete in 1995. This paper provides an overview of the requirements, design issues, and architecture of HPSS, as well as a description of the distributed, multi-organization industry and national laboratory HPSS project.

7951 (UCRL-JC–115318-Rev.1) **The High Performance Storage System: Revision 1.** Coyne, R.A. (IBM Federal Systems Co., Houston, TX (United States)); Hulen, H.; Watson, R. Lawrence Livermore National Lab., CA (United States). Sep 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-931115–13-Rev.1: Supercomputing conference on high performance computing and communications, Portland, OR (United States), 15-19 Nov 1993). Order Number DE94004350. Source: OSTI; NTIS; GPO Dep.

The National Storage Laboratory (NSL) was organized to develop, demonstrate and commercialize technology for the storage systems that will be the future repositories for our national information assets. Within the NSL four Department of Energy laboratories and IBM Federal Systems Company have pooled their resources to develop an entirely new High Performance Storage System (HPSS). The HPSS project concentrates on scalable parallel storage systems for highly parallel computers as well as traditional supercomputers and workstation clusters. Concentrating on meeting the high end of storage system and data management requirements, HPSS is designed using network-connected storage devices to transfer data at rates of 100 million bytes per second and beyond and to handle storage capacities measured in petabytes. The resulting products will be portable to many vendor's platforms. The three year project is targeted to be complete in 1995. This paper provides an overview of the requirements, design issues, and architecture of HPSS, as well as a description of the distributed, multi-organization industry and national laboratory HPSS project.

7952 (UCRL-JC–115601) **A concurrent, multigroup, discrete ordinates model of neutron transport.** Dorr, M.R.; Still, C.H. Lawrence Livermore National Lab., CA (United States). 22 Oct 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9310220–3: Institute of Electrical and Electronic Engineers (IEEE) meeting on scalable parallel libraries, Starkville, MS (United States), 6-8 Oct 1993). Order Number DE94004334. Source: OSTI; NTIS; GPO Dep.

The authors present an algorithm for the concurrent solution of the linear system arising from a multigroup, discrete ordinates model of neutron transport. The target architectures consist of distributed memory computers ranging from workstation clusters to massively parallel computers. Based on an analysis of the memory requirement and floating point complexity of matrix-vector multiplication in the iterative solution of the linear system, the authors propose a data layout and communication strategy designed to achieve scalability with respect to all phase space variables. Numerical results are presented to demonstrate the performance of the algorithm on the nCUBE/2.

7953 (WSRC-MS–93-168) **Risk assessment data banks at the Savannah River Site.** Townsend, C.S.; Durant, W.S.; Baughman, D.F. Westinghouse Savannah River Co., Aiken, SC (United States). [1993]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940312–11: 2. Probabilistic safety assessment and management conference (PSAM), San Diego, CA (United States), 20-24 Mar 1994). Order Number DE94001190. Source: OSTI; NTIS; INIS; GPO Dep.

In the risk assessment business, it is a well known fact that past mistakes will not be remembered if nothing is done to record them and make them available for future reference and review. The Savannah River Site maintains a computer database system for nonreactor facilities that contains a compilation of the incidents that have occurred since the start up of the Site in 1953. The nationally

recognized data banks are highly valued across the US Department of Energy (DOE) complex for their use in risk-related analyses. They provide data for uses such as failure rate analyses, equipment reliability and breakdown studies, project justification, incident investigations, design studies, Safety Analysis Reports, Process Hazards Reviews, consequence analyses, quality assurance studies, trend analyses, management decision, administrative control effectiveness studies, and process problem solving. Five risk assessment data banks exist in the areas of reprocessing, fuel fabrication, waste management, tritium, and the Savannah River Technology Center. The data banks are comprised of approximately one-third million entries collectively and continue to grow at a rate of about two hundred entries per day.

9903 Information Handling

Refer also to citation(s) 6804, 7377, 7933, 7935, 7947, 7950

7954 (ANL/DIS/CP–81216) **Data considerations for modelbases.** Sutter, R.J.; Kero, R.E.; Campbell, A.P. Argonne National Lab., IL (United States). [1993]. 9p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9311148–1: Military Operations Research Society (MORS) mini symposium on simulation data and its management, Falls Church, VA (United States), 16-18 Nov 1993). Order Number DE94004614. Source: OSTI; NTIS; GPO Dep.

With increased emphasis on improving the approach toward model and simulation development, modelbase architectures offer one potential solution for solving interoperability and code reuse problems, as well as for providing a method to guide investment strategies. The adoption of a modelbase concept will require new approaches toward data sources: their definitions, their usage regulations, their life-cycle management, as well as their accessibility during the construction of models and simulations. To support future modelbase development and the construction of new models and simulations, this paper will address the need for: (1) self-describing data, (2) true data independence from application software, (3) multiple levels of granularity in data, and (4) dynamic module-specific data validation. In conjunction with these topics, the production and consumption of identifiable data by modelbase modules will also be described. The paper will address the bipartite structure of data - instantiated data together with its associated meta data, as well as the accessibility and potential uses of both of these information sources. This effort goes far beyond a common data dictionary since the data must not only describe itself, but also its valid uses. The current and future role of data dictionaries will be discussed in terms of this new nature of data required by future Modeling and Simulation (M & S) efforts.

7955 (K/DSRD/FTR–170) **Travel to France for the International Organization for Standardization work on computer security techniques: Foreign trip report, October 10–22, 1993.** Chester, R.O. Oak Ridge K-25 Site, TN (United States). 24 Nov 1993. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OT21400. Order Number DE94004158. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This travel report describes the trip made by the traveler to the Association Francaise de Normalisation, Paris, France. The traveler is Recording Secretary of the American National Standards Institute Committee X3T4, Information Technology Security Techniques. She attended the October 1993, plenary meeting of the International Organization for Standardization Sub-Committee on information technology security techniques and a meeting of the Working Group on security techniques and mechanisms, which were held in Paris, France. Thirteen member nations participated in ballot comment resolution on the following draft international standards: Data integrity mechanisms using a cryptographic check function employing a block cipher algorithm, Hash functions - general framework, Hash functions using a n-bit block cipher algorithm. Publication of these documents as international standards will now take place. The following committee drafts were proposed as draft international standards: Entity authentication mechanisms using non-reversible functions, Non-repudiation using symmetric encipherment algorithms, Key management mechanisms using symmetric techniques, Key management mechanisms using asymmetric techniques. Liaison statements on key management by means of asymmetric algorithms between SC27 and the ISO Bank Operations and Procedures Technical Committee of SC21, Information Retrieval, Transfer and Management for Open Systems Interconnection, were prepared.

7956 (LIU-TEK-LIC–93-5) **Data Quality.** Linkoeping Studies in Science and Technology, 363. Wadstroemer, N. Linkoeping Univ. (Sweden). Dept. of Electrical Engineering. Feb 1993. 86p. Order Number DE94730422. Source: OSTI; NTIS.

There is a need to measure the quality of data to be able to determine if data are useful for different purposes and to be able to determine if different methods for protection of the quality of data are effective. Data are symbols from a given set which do not have a given meaning. The receiver interprets data in his context as information. If the interpretation is different from the collectors interpretation, data will from the receivers point of view have a poor quality. Data will not give a true image of the objects. Data quality is defined as the usefulness of data for a given purpose and a given user. In this thesis we present a reference model of data usage for decision making. The model is used to define data quality and to propose how data quality can be measured. We also propose some methods for utilising given data for a given purpose to achieve ideal decisions. We also make a brief philosophical study of the data quality problem and the proposed model. 18 refs

7957 (NUREG–1487-Vol.1) **Fiscal years 1994–1998 Information Technology Strategic Plan: Volume 1.** Nuclear Regulatory Commission, Washington, DC (United States). Office of Information Resources Management. Nov 1993. 21p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

A team of senior managers from across the US Nuclear Regulatory Commission (NRC), working with the Office of Information Resources Management (IRM), has completed an NRC Strategic Information Technology (IT) Plan. The Plan addresses three major areas: (1) IT Program Management, (2) IT Infrastructure, and (3) Information and Applications Management. Key recommendations call for accelerating the replacement of Agency workstations, implementing a new document management system, applying business process reengineering to selected Agency work processes, and establishing an Information Technology Council to advise the Director of IRM.

7958 (NUREG/GR–0010) **Hybrid digital signal processing and neural networks for automated diagnostics using NDE methods.** Upadhyaya, B.R. (Tennessee Univ., Knoxville, TN (United States). Dept. of Nuclear Engineering); Yan, W. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Engineering; Tennessee Univ., Knoxville, TN (United States). Dept. of Nuclear Engineering. Nov 1993. 136p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

The primary purpose of the current research was to develop an integrated approach by combining information compression methods and artificial neural networks for the monitoring of plant components using nondestructive examination data. Specifically, data from eddy current inspection of heat exchanger tubing were utilized to evaluate this technology. The focus of the research was to develop and test various data compression methods (for eddy current data) and the performance of different neural network paradigms for defect classification and defect parameter estimation. Feedforward, fully-connected neural networks, that use the back-propagation algorithm for network training, were implemented for defect classification and defect parameter estimation using a modular network architecture. A large eddy current tube inspection database was acquired from the Metals and Ceramics Division of ORNL. These data were used to study the performance of artificial neural networks for defect type classification and for estimating defect parameters. A PC-based data preprocessing and display program was also developed as part of an expert system for data management and decision making. The results of the analysis showed that for effective (low-error) defect classification and estimation of parameters, it is necessary to identify proper feature vectors using different data representation methods. The integration

of data compression and artificial neural networks for information processing was established as an effective technique for automation of diagnostics using nondestructive examination methods.

7959 (PNL-SA–23053) **Strategic planning: Identifying organization information requirements.** Moise, C.S. Pacific Northwest Lab., Richland, WA (United States). [1993]. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9310152–2: 34. Association of Energy Systems, Operations and Programming forum, Seattle, WA (United States), 27-29 Oct 1993). Order Number DE94003719. Source: OSTI; NTIS; GPO Dep.

Historically, information resource management has been left to the "data processing" arm of the organization. With technological movements away from centralized mainframe-based information processing toward distributed client/server-based information processing, almost every part of an organization is becoming more involved with the information technology itself, and certainly more involved with budgeting for the technology. However, users and buyers of information technology frequently remain dependent upon the information systems department for planning what users need and should buy. This paper reviews techniques for identifying requirements throughout an organization and structuring information resources to meet organizational needs. This will include basing information resource needs on meeting business needs, utilizing "internal" and "external" information resource planners, using information mapping, assessing information resources, and developing partnerships.

9904 Law

Refer also to citation(s) 6815

7960 (INIS-XN–467) **AECB Cost Recovery Fees Regulations, amendment.** Canada. 11 Mar 1992. 1p. (In English, French). Order Number DE94609511. Source: OSTI; NTIS (US Sales Only); INIS.

Published in the Canada Gazette Part II, Vol. 126, No 6.

The amendments to the AECB Cost Recovery Fees Regulations have been made with a view to simplifying the registration procedure for obtaining such a certificate or approval under the above Transport Regulations. In effect there will no longer be a need for a separate fee system for registered users of certified package designs. (NEA).

Corporate Author Index

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AC08-93NV11265	**EG and G Energy Measurements, Inc., Las Vegas, NV (United States). Remote Sensing Lab.**	
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AC22-90PC90361	**North Dakota Univ., Grand Forks, ND (United States). Energy and Environmental Research Center**	
	19:6589	DOE/PC/90361–T11
AC22-91PC90042	**UOP, Inc., Des Plaines, IL (United States)**	
	19:6024	DOE/PC/90042–T6
	19:6454	DOE/PC/90042–T4
	19:6455	DOE/PC/90042–T7
AC22-91PC90046	**Union Carbide Chemicals and Plastics Co., Inc., South Charleston, WV (United States). South Charleston Technical Center**	
	19:6025	DOE/PC/90046–T7
	19:6456	DOE/PC/90046–T4
AC22-91PC90182	**Florida Univ., Gainesville, FL (United States)**	
	19:6062	DOE/PC/90182–T11
AC22-91PC91028	**Arkansas Univ., Fayetteville, AR (United States). Dept. of Chemical Engineering**	
	19:6457	DOE/PC/91028–T7
AC22-91PC91030	**Dow Corning Corp., Carrollton, KY (United States)**	
	19:7118	DOE/PC/91030–T6
AC22-91PC91040	**Kentucky Univ., Lexington, KY (United States). Center for Applied Energy Research**	
	19:6032	DOE/PC/91040–29
AC22-91PC91042	**Pennsylvania State Univ., University Park, PA (United States). Dept. of Materials Science and Engineering**	
	19:6033	DOE/PC/91042–6
AC22-91PC91053	**SRI International, Menlo Park, CA (United States). Chemistry Lab.**	
	19:6034	DOE/PC/91053–T5
AC22-91PC91161	**Vortec Corp., Collegeville, PA (United States)**	
	19:7145	DOE/PC/91161–T6
AC22-92BC14886	**Surtek, Inc., Golden, CO (United States)**	
	19:6084	DOE/BC/14886–4
AC22-92MT92001	**Continental Shelf Associates, Inc., Jupiter, FL (United States)**	
	19:6106	DOE/MT/92001–4
AC22-92MT92009	**Resource Technology Corp., Laramie, WY (United States)**	
	19:6104	DOE/MT/92009–4
AC22-92PC91346	**Carnegie-Mellon Univ., Pittsburgh, PA (United States). Center for Energy and Environmental Studies**	
	19:6592	DOE/PC/91346–3
AC22-92PC92108	**Energy International Corp., Pittsburgh, PA (United States)**	
	19:6037	DOE/PC/92108–T3
AC22-92PC92176	**United Technologies Research Center, East Hartford, CT (United States)**	
	19:6075	DOE/PC/92176–T3
AC22-93PC92206	**AMAX Research and Development Center, Golden, CO (United States)**	
	19:6014	DOE/PC/92206–T2
AC34-90DP62349	**EG and G Rocky Flats, Inc., Golden, CO (United States)**	
	19:6133	DOE/FTR–93018110
	19:6284	RFP–4745
	EG and G Rocky Flats, Inc., Golden, CO (United States). Rocky Flats Plant	
	19:6285	RFP–4748
AC34-90RF62349	**EG and G Rocky Flats, Inc., Golden, CO (United States)**	
	19:7507	RFP–4747
AC35-89ER40486	**Superconducting Super Collider Lab., Dallas, TX (United States)**	
	19:7229	SSCL–654
	19:7286	SSCL–651

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	19:7287	SSCL-Preprint–520
	19:7288	SSCL-SR–1228
	19:7349	SSCL-Preprint–516
	19:7350	SSCL-Preprint–535
AC65-90WA05637	National Renewable Energy Lab., Golden, CO (United States)	
	19:6338	NREL/CP–200-5768-Vol.1
	19:6339	NREL/CP–200-5768-Vol.1
AC79-92BP21985	USDOE Bonneville Power Administration, Portland, OR (United States)	
	19:6461	DOE/BP/21985–5
AI01-93NE32170	Johns Hopkins Univ., Laurel, MD (United States). Applied Physics Lab.	
	19:6629	DOE/NE/32170–23
AI02-92ER25118	Jet Propulsion Lab., Pasadena, CA (United States)	
	19:7910	DOE/ER/25118–1
AI05-76EV03688	National Oceanic and Atmospheric Administration, Oak Ridge, TN (United States). Air Resources Lab. Atmospheric Turbulence and Diffusion Div.	
	19:7397	DOE/EV/03688–T3
AI05-86ER53237	National Inst. of Standards and Technology, Gaithersburg, MD (United States)	
	19:7805	DOE/ER/53237–T1
AI05-88ER13823	Argonne National Lab., IL (United States)	
	19:7109	CONF-9305134–
	19:7362	CONF-9305134–
	National Inst. of Standards and Technology, Gaithersburg, MD (United States). Chemical Science and Technology Lab.	
	19:7092	DOE/ER/13823–T2
AI05-89ER53281	Naval Research Lab., Washington, DC (United States). Condensed Matter and Radiation Sciences Div.	
	19:7806	DOE/ER/53281–T1
	19:7807	DOE/ER/53281–T2
	19:7808	DOE/ER/53281–T3
AI06-91RL12092	National Oceanic and Atmospheric Administration, Boulder, CO (United States). Wave Propagation Lab.	
	19:7401	DOE/RL/12092–T1
AI08-92NV10874	Geological Survey, Denver, CO (United States)	
	19:7461	USGS-WRI–92-4065
	Geological Survey, Menlo Park, CA (United States)	
	19:6202	USGS-OFR–92-450
AI21-90MC27246	Bureau of Mines, Pittsburgh, PA (United States). Pittsburgh Research Center	
	19:6119	DOE/MC/27246–3480
AS05-80ER10629	Oklahoma Univ., Norman, OK (United States)	
	19:7302	DOE/ER/10629–T2
	19:7303	DOE/ER/10629–T3
	19:7304	DOE/ER/10629–T5
	19:7305	DOE/ER/10629–T6
	19:7306	DOE/ER/10629–T7
	19:7620	DOE/ER/10629–T4
	Oklahoma Univ., Norman, OK (United States). Dept. of Physics and Astronomy	
	19:7307	DOE/ER/10629–T8
AS05-90ER40576	North Carolina State Univ., Raleigh, NC (United States). Dept. of Electrical and Computer Engineering	
	19:7260	DOE/ER/40576–T1
AT03-79ER10388	Rockwell International Corp., Canoga Park, CA (United States). Rocketdyne Div.	
	19:7851	DOE/ER/10388–T1
BI79-87BP35885	Washington Univ., Seattle, WA (United States). Center for Quantitative Science	
	19:7482	DOE/BP/35885–3
FC02-93ER54186	Massachusetts Inst. of Tech., Cambridge, MA (United States). Plasma Fusion Center	
	19:7867	DOE/FTR–94001875
	19:7870	DOE/FTR–94004970
FC03-90ER61010	California Univ., Davis, CA (United States)	
	19:7392	DOE/ER/61010–T9
	19:7393	DOE/ER/61010–T10
	National Inst. for Global Environmental Change, Cambridge, MA (United States). Northeast Regional Center	
	19:6776	DOE/ER/61010–T24
FC08-93NV11417	Nevada Univ., Reno, NV (United States). Desert Research Inst.	
	19:6153	DOE/NV/11417–1
	19:6154	DOE/NV/11417–2
FC21-86MC11076	University of Wyoming Research Corp., Laramie, WY (United States). Western Research Inst.	
	19:6045	DOE/MC/11076–3554
	Western Research Inst., Laramie, WY (United States)	
	19:6113	DOE/MC/11076–3539
FC21-92MC29061	South Carolina Energy Research and Development Center, Clemson, SC (United States)	
	19:6576	DOE/MC/29061–94/C0239
FC21-92MC29227	Southern California Gas Co., Los Angeles, CA (United States)	
	19:6836	DOE/MC/29227–3510
	19:6837	DOE/MC/29227–3511
FC21-93MC30098	North Dakota Univ., Grand Forks, ND (United States). Energy and Environmental Research Center	
	19:6046	DOE/MC/30098–3552
FC22-83FE60149	National Inst. for Petroleum and Energy Research, Bartlesville, OK (United States)	
	19:6082	NIPER–724
	19:6087	NIPER–661
	19:6088	NIPER–714
	19:6089	NIPER–727
FC22-90PC89651	Southern Co. Services, Inc., Birmingham, AL (United States)	
	19:6585	DOE/PC/89651–T10
	19:6586	DOE/PC/89651–T11
FC22-90PC89655	ABB Environmental Systems, Birmingham, AL (United States)	
	19:6587	DOE/PC/89655–T9
FC22-90PC89658	Bethlehem Steel Corp., PA (United States)	
	19:6056	DOE/PC/89658–T6
FC22-90PC89659	Babcock and Wilcox Co., Alliance, OH (United States)	
	19:6588	DOE/PC/89659–T14
FC22-90PC89663	CQ, Inc., Homer City, PA (United States)	
	19:6047	DOE/PC/89663–T10
FC22-91PC90546	Bechtel Corp., San Francisco, CA (United States)	
	19:6058	DOE/PC/90546–T9
	19:6590	DOE/PC/90546–T10
	19:6591	DOE/PC/90546–T11
FC22-92PC92162	Pennsylvania State Univ., University Park, PA (United States)	
	19:6073	DOE/PC/92162–T1
	19:6074	DOE/PC/92162–T2
FC22-93BC14958	Lomax Exploration Co., Salt Lake City, UT (United States)	
	19:6085	DOE/BC/14958–4

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FC65-93WA09072	National Renewable Energy Lab., Golden, CO (United States)	
	19:6379	NREL/CP–200-5768-Vol.2
FG01-92EW50625	Medical Univ. of South Carolina, Charleston, SC (United States)	
	19:6234	DOE/EW/50625–T12
	19:6261	DOE/EW/50625–T2
	19:6262	DOE/EW/50625–T4
	19:6263	DOE/EW/50625–T11
	19:6777	DOE/EW/50625–T5
	19:6778	DOE/EW/50625–T9
	19:6779	DOE/EW/50625–T10
	19:7469	DOE/EW/50625–T7
	19:7492	DOE/EW/50625–T3
	19:7511	DOE/EW/50625–T13
FG01-93EW53023	Tulane Univ., New Orleans, LA (United States)	
	19:7470	DOE/EW/53023–T3
FG02-84ER52111	Illinois Univ., Urbana, IL (United States). Fusion Technology Lab.	
	19:7853	DOE/ER/52111–6
FG02-85ER13331	Argonne National Lab., IL (United States)	
	19:7141	CONF-9305134–
FG02-85ER45184	Michigan Univ., Ann Arbor, MI (United States). Dept. of Nuclear Engineering	
	19:6962	DOE/ER/45184–9
FG02-85ER53198	Wisconsin Univ., Madison, WI (United States). Dept. of Physics	
	19:7798	DOE/ER/53198–227
	Wisconsin Univ., Madison, WI (United States). Plasma Physics Research	
	19:7799	DOE/ER/53198–229
	19:7800	DOE/ER/53198–230
	19:7801	DOE/ER/53198–231
FG02-85ER53211	Rensselaer Polytechnic Inst., Troy, NY (United States)	
	19:7802	DOE/ER/53211–12
FG02-85ER53212	Wisconsin Univ., Madison, WI (United States)	
	19:7803	DOE/ER/53212–T2
FG02-86ER13484	Argonne National Lab., IL (United States)	
	19:7010	CONF-9305134–
FG02-86ER13528	Dartmouth Coll., Hanover, NH (United States). Thayer School of Engineering	
	19:7171	DOE/ER/13528–7
FG02-86ER13552	Clarkson Univ., Potsdam, NY (United States). Dept. of Chemical Engineering	
	19:7091	DOE/ER/13552–10
FG02-86ER13564	Massachusetts Inst. of Tech., Cambridge, MA (United States)	
	19:7113	DOE/ER/13564–12
FG02-86ER40281	Columbia Univ., New York, NY (United States)	
	19:7706	DOE/ER/40281–8
FG02-86ER40291	State Univ. of New York, Binghamton, NY (United States). Dept. of Physics	
	19:7597	DOE/ER/40291–20
FG02-86ER53222	Columbia Univ., New York, NY (United States). Plasma Physics Lab.	
	19:7804	DOE/ER/53222–108
FG02-86ER60437	Chicago Univ., IL (United States). Enrico Fermi Inst.	
	19:7752	DOE/ER/60437–8
FG02-87ER13726	Argonne National Lab., IL (United States)	
	19:6488	CONF-9305134–
FG02-87ER13775	State Univ. of New York, Buffalo, NY (United States). Dept. of Chemistry	
	19:7114	DOE/ER/13775–5
FG02-87ER40316	Washington Univ., St. Louis, MO (United States)	
	19:7707	DOE/ER/40316–7
FG02-87ER40342	Colorado School of Mines, Golden, CO (United States). Dept. of Physics	
	19:7708	DOE/ER/40342–6
FG02-87ER60581	Colorado State Univ., Fort Collins, CO (United States)	
	19:7432	DOE/ER/60581–6
FG02-88ER13849	Rochester Univ., NY (United States)	
	19:7747	DOE/ER/13849–6
FG02-88ER13913	Argonne National Lab., IL (United States)	
	19:7162	CONF-9305134–
FG02-88ER13927	Argonne National Lab., IL (United States)	
	19:7161	CONF-9305134–
FG02-88ER13929	Argonne National Lab., IL (United States)	
	19:7167	CONF-9305134–
FG02-88ER25053	New York Univ., NY (United States). Courant Inst. of Mathematical Sciences	
	19:7908	DOE/ER/25053–T2
FG02-88ER40404	Indiana Univ., Bloomington, IN (United States)	
	19:7710	DOE/ER/40404–5
FG02-88ER40406	Washington Univ., St. Louis, MO (United States). Dept. of Chemistry	
	19:7677	DOE/ER/40406–6
FG02-88ER40412	Purdue Univ., Lafayette, IN (United States). Dept. of Physics	
	19:7598	DOE/ER/40412–T3
FG02-88ER40414	Rochester Univ., NY (United States)	
	19:7711	DOE/ER/40414–6
FG02-88ER40425	Rochester Univ., NY (United States). Dept. of Physics and Astronomy	
	19:7671	DOE/ER/40425–258
FG02-88ER40448	Rensselaer Polytechnic Inst., Troy, NY (United States). Dept. of Physics	
	19:7564	DOE/ER/40448–6
FG02-88ER40452	Brown Univ., Providence, RI (United States). Dept. of Physics	
	19:7308	DOE/ER/40452–9
FG02-89ER12891	Michigan Univ., Ann Arbor, MI (United States)	
	19:7188	CONF-9011127–20-Vugraphs
	Michigan Univ., Ann Arbor, MI (United States). Dept. of Nuclear Engineering	
	19:6122	DOE/ER/12891–1
	19:6123	DOE/ER/12891–2
	19:7189	DOE/ER/12891–3
FG02-89ER12898	Georgia Inst. of Tech., Atlanta, GA (United States). School of Mechanical Engineering	
	19:6601	DOE/ER/12898–2
FG02-89ER14017	Rochester Univ., NY (United States). Dept. of Physics and Astronomy	
	19:7789	DOE/ER/14017–5
FG02-89ER14043	Argonne National Lab., IL (United States)	
	19:7170	CONF-9305134–
FG02-89ER14079	Colorado School of Mines, Golden, CO (United States). Center for Wave Phenomena	
	19:7516	DOE/ER/14079–29
FG02-89ER40503	Pittsburgh Univ., PA (United States). Dept. of Physics	
	19:7309	DOE/ER/40503–T1
FG02-89ER51124	Grumman Corp., Princeton, NJ (United States)	
	19:7852	DOE/ER/51124–13
FG02-89ER52158	Wisconsin Univ., Madison, WI (United States). Fusion Technology Inst.	
	19:7854	DOE/ER/52158–11
FG02-89ER53291	Wisconsin Univ., Madison, WI (United States). Plasma Physics Research	
	19:7809	DOE/ER/53291–225

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FG02-89ER60844	Michigan Univ., Ann Arbor, MI (United States)	
	19:7117	DOE/ER/60844–1
	19:7433	DOE/ER/60844–3
FG02-89ER60848	Michigan State Univ., East Lansing, MI (United States)	
	19:7496	DOE/ER/60848–3
FG02-90ER12983	Virginia Univ., Charlottesville, VA (United States). Dept. of Mechanical, Aerospace and Nuclear Engineering	
	19:6689	DOE/ER/12983–1
FG02-90ER14104	Columbia Univ., New York, NY (United States)	
	19:7050	DOE/ER/14104–4
FG02-90ER14105	Ohio State Univ., Columbus, OH (United States). Dept. of Chemistry	
	19:7128	DOE/ER/14105–4
FG02-90ER14113	Purdue Univ., Lafayette, IN (United States). Dept. of Earth and Atmospheric Sciences	
	19:7517	DOE/ER/14113–3
FG02-90ER14139	Argonne National Lab., IL (United States)	
	19:7164	CONF-9305134–
FG02-90ER54084	Massachusetts Inst. of Tech., Cambridge, MA (United States). Plasma Fusion Center	
	19:7860	DOE/FTR–93018329
FG02-90ER61054	Bern Univ. (Switzerland)	
	19:7467	DOE/ER/61054–3
FG02-90ER61059	Utah Univ., Salt Lake City, UT (United States). Dept. of Meteorology	
	19:7394	DOE/ER/61059–2
FG02-90ER61065	Atmospheric and Environmental Research, Inc., Cambridge, MA (United States)	
	19:7395	DOE/ER/61065–3
FG02-90ER61072	State Univ. of New York, Albany, NY (United States). Atmospheric Sciences Research Center	
	19:7352	DOE/ER/61072–7
FG02-91CE23810	Dayton Univ., OH (United States). Research Inst.	
	19:7111	DOE/CE/23810–20D
	National Inst. of Standards and Technology, Boulder, CO (United States). Thermophysics Div.	
	19:7048	DOE/CE/23810–22A
	Imagination Resources, Inc., Dublin, OH (United States)	
	19:7047	DOE/CE/23810–15
	Calm (James M.), Great Falls, VA (United States)	
	19:7390	DOE/CE/23810–22E
	Spauschus Associates, Inc., Stockbridge, GA (United States)	
	19:7049	DOE/CE/23810–22B
FG02-91ER14221	City Coll., New York, NY (United States). Dept. of Chemical Engineering	
	19:6091	DOE/ER/14221–3
FG02-91ER40654	Harvard Univ., Cambridge, MA (United States)	
	19:7622	DOE/ER/40654–3
FG02-91ER40661	Indiana Univ., Bloomington, IN (United States). Dept. of Physics	
	19:7566	DOE/ER/40661–5
FG02-91ER40673	Fairfield Univ., CT (United States)	
	19:7310	DOE/ER/40673–2
FG02-91ER40677	Illinois Univ., Urbana, IL (United States). Loomis Lab. of Physics	
	19:7568	DOE/ER/40677–2-Pt.1
	19:7569	DOE/ER/40677–2-Pt.2
FG02-91ER40685	Rochester Univ., NY (United States). Dept. of Physics and Astronomy	
	19:7623	DOE/ER/40685–759
FG02-91ER40688	Brown Univ., Providence, RI (United States). Dept. of Physics	
	19:7311	DOE/ER/40688–2
FG02-91ER54111	InterScience, Inc., Troy, NY (United States)	
	19:7810	DOE/ER/54111–3
FG02-91ER61256	Michigan Univ., Ann Arbor, MI (United States)	
	19:7488	DOE/ER/61256–T2
FG02-91ER75640	Austin Children's Museum, TX (United States)	
	19:6910	DOE/ER/75640–1
FG02-91ER81187	LSR Technologies, Inc., Acton, MA (United States)	
	19:6916	DOE/ER/81187–94/C0255
FG02-92ER25137	Minnesota Univ., Minneapolis, MN (United States)	
	19:7911	DOE/ER/25137–1
FG02-92ER40692	Iowa State Univ. of Science and Technology, Ames, IA (United States). Dept. of Physics and Astronomy	
	19:7715	DOE/ER/40692–2
FG02-92ER54139	Wisconsin Univ., Madison, WI (United States)	
	19:7811	DOE/ER/54139–2
FG02-92ER61365	Wisconsin Univ., Madison, WI (United States)	
	19:7396	DOE/ER/61365–T2
FG02-92ER61403	Notre Dame Univ., IN (United States). Dept. of Civil Engineering and Geological Sciences	
	19:7051	DOE/ER/61403–2
FG02-92ER61443	University of Southern Mississippi, Stennis Space Center, MS (United States)	
	19:7353	DOE/ER/61443–2
FG02-93ER14320	George Washington Univ., Washington, DC (United States). Office of Sponsored Research	
	19:7093	DOE/ER/14320–1
FG02-93ER40756	Ohio Univ., Athens, OH (United States). Dept. of Physics and Astronomy	
	19:7716	DOE/ER/40756–1
FG02-93ER40787	Yale Univ., New Haven, CT (United States)	
	19:7312	DOE/ER/40787–1
FG02-93ER45503	Princeton Univ., NJ (United States)	
	19:7116	DOE/ER/45503–1
FG02-93ER54196	Wisconsin Univ., Madison, WI (United States). Dept. of Electrical and Computer Engineering	
	19:7812	DOE/ER/54196–1
FG02-93ER54197	Maryland Univ., College Park, MD (United States)	
	19:7813	DOE/ER/54197–1
FG02-93ER61540	Princeton Univ., NJ (United States)	
	19:7468	DOE/ER/61540–1
FG03-90ER14148	Argonne National Lab., IL (United States)	
	19:7165	CONF-9305134–
FG03-90ER14157	Argonne National Lab., IL (United States)	
	19:7012	CONF-9305134–
FG03-91ER14196	Argonne National Lab., IL (United States)	
	19:7009	CONF-9305134–
FG03-92ER40707	California Univ., Santa Barbara, CA (United States). Inst. for Theoretical Physics	
	19:7596	CONF-9201167–Summ.
FG05-80ET53088	Texas Univ., Austin, TX (United States). Inst. for Fusion Studies	
	19:7814	DOE/ET/53088–623-Rev.
	19:7815	DOE/ET/53088–627

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	19:7816	DOE/ET/53088–629
	19:7817	DOE/ET/53088–632
	19:7818	DOE/ET/53088–T4
FG05-86ER13538	Louisville Univ., KY (United States). Dept. of Chemistry	
	19:7112	DOE/ER/13538–8
FG05-86ER40272	Florida Univ., Gainesville, FL (United States). Inst. for Fundamental Theory	
	19:7563	DOE/ER/40272–194
FG05-87ER40314	Tennessee Technological Univ., Cookeville, TN (United States). Dept. of Physics	
	19:7670	DOE/ER/40314–7
FG05-87ER40374	Houston Univ., TX (United States). Dept. of Physics	
	19:7197	DOE/ER/40374–73
FG05-88ER13839	Houston Univ., TX (United States). Dept. of Mechanical Engineering	
	19:7172	DOE/ER/13839–T2
FG05-88ER13844	Georgia Inst. of Tech., Atlanta, GA (United States)	
	19:7746	DOE/ER/13844–T1
FG05-88ER40442	Triangle Universities Nuclear Lab., Durham, NC (United States)	
	19:7713	DOE/ER/40442–6
FG05-88ER40445	Louisiana State Univ., Baton Rouge, LA (United States)	
	19:7621	DOE/ER/40445–43
FG05-89ER75531	Alabama A and M Univ., Normal, AL (United States). Dept. of Physics	
	19:7538	DOE/ER/75531–1
FG05-90ER40592	Duke Univ., Durham, NC (United States). Dept. of Physics	
	19:7601	DOE/ER/40592–3
FG05-90ER60991	Memphis State Univ., TN (United States). Dept. of Biology	
	19:6260	DOE/ER/60991–T3
FG05-91ER14165	Tulane Univ., New Orleans, LA (United States). Dept. of Chemical Engineering	
	19:7115	DOE/ER/14165–T1
FG05-91ER14215	Argonne National Lab., IL (United States)	
	19:6083	CONF-9305134–
FG05-91ER25100	Maryland Univ., Baltimore, MD (United States)	
	19:7909	DOE/ER/25100–2
FG05-91ER40627	Tennessee Univ., Knoxville, TN (United States). Dept. of Physics and Astronomy	
	19:7565	DOE/ER/40627–3
FG05-91ER40665	Duke Univ., Durham, NC (United States). High Energy Physics Group	
	19:7567	DOE/ER/40665–T2
FG05-91ER81236	Cryogenic Applications F, Inc., Clinton, TN (United States)	
	19:7850	CONF-931018–74
FG05-92ER61375	Student Pugwash U.S.A., Washington, DC (United States)	
	19:6768	CONF-9206415–
FG06-88ER40402	Oregon State Univ., Corvallis, OR (United States)	
	19:7709	DOE/ER/40402–6
FG06-88ER40427	Washington Univ., Seattle, WA (United States). Dept. of Physics	
	19:7599	DOE/ER/40427–20-N93
	19:7600	DOE/ER/40427–21-N93
	19:7712	DOE/ER/40427–15-N93
FG06-90ER40537	Washington Univ., Seattle, WA (United States). Nuclear Physics Lab.	
	19:7714	DOE/ER/40537–31
FG21-89MC26031	New Mexico Petroleum Recovery Research Center, Socorro, NM (United States)	
	19:6086	DOE/MC/26031–3462
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80134	19:6932	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004608	MF-404
80230	19:7786	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005132	MF-404
81484	19:7787	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004627	MF-222; MF-404
81580	19:7044	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005120	MF-404
ANL/NDM–					
131	19:7689	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005258	MF-411
ANL/PHY/CP–					
80398	19:7613	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003204	MF-413
81316	19:7234	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004570	MF-413
ANL/RE/LWR–					
92-5	19:6730	*See* NUREG/CR–6025			
ANL/XFD/CP–					
79550	19:7235	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004619	MF-411
80249	19:7236	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004617	MF-411
80819	19:7300	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001334	MF-404; MF-411
81399	19:7289	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004616	MF-404; MF-411
81491	19:7237	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004618	MF-411
ANSP-M–					
23	19:6629	*See* DOE/NE/32170–23			
ARL-TR–					
095-Vol.1	19:7500	OSTI; NTIS (US Sales Only); INIS		DE94608817	
BGS-TR-WE–					
92/32.	19:7435	*See* DOE-HMIP-RR–93.026			
BNL–					
48941	19:7214	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004973	MF-414
49214-Rev.(12/3/93)	19:7199	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005509	MF-400
49231	19:7387	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003989	MF-402
49312	19:7215	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004234	MF-414
49420	19:7238	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004348	MF-414
49554-Rev.	19:7216	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004950	MF-414
49587	19:7491	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003085	MF-400
49593	19:7614	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004235	MF-413
49621	19:7672	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003991	MF-413
49626	19:7690	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003894	MF-413
49630	19:6114	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004725	MF-350
49632	19:7351	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004948	MF-406
49639	19:7140	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003992	MF-703
49648	19:7239	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003990	MF-414
49665	19:7615	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003196	MF-414
49690	19:7388	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003195	MF-402
49706	19:7788	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005187	MF-335
49709	19:7429	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005145	MF-902

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49743	19:7217	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004971	MF-414
49777	19:7749	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005508	MF-400
49782	19:7750	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004946	MF-414
52389	19:7561	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002946	PC-413; PC-414
70389	19:7240	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004968	MF-414
BNL-NUREG–					
48967	19:6702	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE93015394	
48994	19:6703	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE93015785	
49610	19:6704	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003010	
49671	19:6705	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003995	
49711	19:6706	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004345	
52364	19:6729	*See* NUREG/CR–5995			
BNWC–					
91	19:6142	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003749	MF-711
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93-10	19:7571	OSTI; NTIS (US Sales Only); INIS		DE94734004	
93-11	19:7572	OSTI; NTIS (US Sales Only); INIS		DE94733996	
93-13	19:7525	OSTI; NTIS (US Sales Only); INIS		DE94734005	
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91-110	19:7616	OSTI; NTIS (US Sales Only); INIS		DE94611207	
91-116	19:7793	OSTI; NTIS (US Sales Only); INIS		DE94611442	
91-117	19:7776	OSTI; NTIS (US Sales Only); INIS		DE94611538	
91-74	19:7526	OSTI; NTIS (US Sales Only); INIS		DE94611072	
91-98	19:7527	OSTI; NTIS (US Sales Only); INIS		DE94611073	
92-1	19:7528	OSTI; NTIS (US Sales Only); INIS		DE94611074	
92-39	19:7290	OSTI; NTIS (US Sales Only); INIS		DE94610767	
92-57	19:7595	OSTI; NTIS (US Sales Only); INIS		DE94611157	
92-58	19:7794	OSTI; NTIS (US Sales Only); INIS		DE94611466	
92-60	19:7795	OSTI; NTIS (US Sales Only); INIS		DE94611459	
92-61	19:7617	OSTI; NTIS (US Sales Only); INIS		DE94611173	
BfS-KT–					
5/93-REV-1	19:6803	OSTI; NTIS (US Sales Only); INIS		DE94734093	
BfS-ST–					
5/93	19:7301	OSTI; NTIS (US Sales Only); INIS		DE94734045	
CALT–					
68-1869	19:7297	*See* LBL-PUB–5379			
CAP–					
102-93C	19:7215	*See* BNL–49312			
103-CK-93R	19:7238	*See* BNL–49420			
CEA-CONF–					
11409	19:7691	OSTI; NTIS (US Sales Only); INIS		DE94611370	
11534	19:6143	OSTI; NTIS (US Sales Only); INIS		DE94610945	
11609	19:6144	OSTI; NTIS (US Sales Only); INIS		DE94610950	
CEA-N–					
2734	19:7907	OSTI; NTIS (US Sales Only)		DE94728750	
CMI-R–					
92/A25016	19:6096	OSTI; NTIS		DE94730387	
CMR–					
92-A10005	19:6117	OSTI; NTIS		DE94730381	
92-A15009	19:6110	OSTI; NTIS		DE94730380	
92-A15016	19:6111	OSTI; NTIS		DE94730379	
92-A30009	19:6767	OSTI; NTIS; INIS		DE94730386	
92-A30013	19:6817	OSTI; NTIS; INIS		DE94730368	
CONF-8703128–		(International conference on advances in experimental methods for colliding beam physics; Stanford, CA (United States); 9-13 Mar 1987)			
11	19:7276	*See* SLAC-PUB–4252			
CONF-900525–		(2. international symposium on stabilization/solidification of hazardous, radioactive and mixed waste; Williamsburg, VA (United States); 29 May - 1 jun 1990)			
5	19:6160	*See* ENEA-RT-AMB–92-03			
CONF-900640–		(International conference on rock joints; Loen (Norway); 4-6 Jun 1990)			
8	19:7520	*See* LBL–30751			
CONF-9008144–		(Workshop on possible differences in biological availability of isotopes of Plutonium; Las Vegas, NV (United States); 28-29 Aug 1990)			
Summ.	19:7459	*See* UCRL-ID–110051			

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CONF-9010172–		(61. shock and vibration symposium; Pasadena, CA (United States); 16-18 Oct 1990)			
6	19:7160	*See* WAPD-T–2944			
CONF-901053–		(Fall conference of the American Society for Nondestructive Testing; Seattle, WA (United States); 9-12 Oct 1990)			
5	19:7184	*See* WAPD-T–2947			
CONF-9010544–		(KUITU seminar on energy efficient mechanical pulping; Espoo (Finland); 17 Oct 1990)			
	19:6881	*See* KCL-KUITU–13			
CONF-9011127–		(32. annual meeting of the American Physical Society - Division of Plasma Physics (APS/DPP); Cincinnati, OH (United States); 12-16 Nov 1990)			
20-Vugraphs	19:7188	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004849	MF-406
CONF-9011339–		(Impact of climatic change on natural ecosystems, with emphasis on boreal and arctic/alpine areas; Trondheim (Norway); 27-29 Nov 1990)			
	19:6790	*See* NEI-NO–383			
CONF-910414–		(International topical meeting on advances in mathematics, computation and reactor physics; Pittsburgh, PA (United States); 28 Apr - 2 may 1991)			
43	19:6651	*See* WAPD-T–2949			
CONF-911107–		(1991 winter meeting of the American Nuclear Society (ANS); San Francisco, CA (United States); 10-15 Nov 1991)			
85	19:6600	*See* WAPD-T–2969			
CONF-9112172–		(KUITU Seminar on energy efficient mechanical pulping; Espoo (Finland); 12 Dec 1991)			
	19:6882	*See* KCL-KUITU–16			
CONF-9201167–		(Workshop on heavy quark symmetry: theory and applications; Santa Barbara, CA (United States); 13-31 Jan 1992)			
Summ.	19:7596	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003559	MF-414
CONF-920220–		(International specialty conference: in situ treatment of contaminated soil and water; Cincinnati, OH (United States); 4-6 Feb 1992)			
2	19:7456	*See* PNL-SA–20825			
CONF-920307–		(Waste management '92; Tucson, AZ (United States); 1-5 Mar 1992)			
101	19:6235	*See* DOE/WIPP–91-047C			
CONF-9204126–		(B factories: state of the art in accelerators, detectors, and physics; Stanford, CA (United States); 6-10 Apr 1992)			
21	19:7206	*See* SLAC-PUB–5843			
CONF-9204276–		(Seminar on research and development in support of technology with military applications; Karachi (Pakistan); 29 Apr 1992)			
	19:6965	*See* INIS-mf–13740			
	19:7055	*See* INIS-mf–13742			
	19:7921	*See* INIS-mf–13741			
CONF-920527–		(1992 incineration conference; Albuquerque, NM (United States); 11-15 May 1992)			
	19:6143	*See* CEA-CONF–11534			
CONF-9206131–		(3. international symposium on the history of particle physics - the rise of the standard model; Stanford, CA (United States); 24-27 Jun 1992)			
5	19:7570	*See* FNAL/C–93/282			
CONF-9206415–		(7. Student Pugwash USA's international conference on visions for a sustinable world; Atlanta, GA (United States); 14-20 Jun 1992)			
	19:6768	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001664	MF-400
CONF-9206419–		(Geophysics and environment: Basic pollution; Rome (Italy); 16-18 Jun 1992)			
1	19:7405	*See* ETDE-IT–93-249			
CONF-9206423–		(Fast neutrons in treatment of neoplasms; Tomsk (Russian Federation); 16-17 Jun 1992)			
	19:7494	*See* INIS-RU–346			

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CONF-9207224–		(European Community for Future Accelerators (ECFA) workshop on $e^{+)e(sup-}$ linear colliders (LC92); Garmisch-Partenkirchen (Germany); 25 Jul - 2 aug 1992)			
1	19:7209	*See* SLAC-PUB–6293			
2	19:7207	*See* SLAC-PUB–6127			
CONF-920815–		(204. American Chemical Society (ACS) national meeting; Washington, DC (United States); 23-28 Aug 1992)			
27	19:6206	*See* WHC-SA–1576			
28	19:6184	*See* PNL-SA–20608			
29	19:6212	*See* WSRC-MS–92-144			
CONF-9208225–		(Advanced light source users meeting; Berkeley, CA (United States); 27-28 Aug 1992)			
	19:7203	*See* LBL–34736			
CONF-9208245–		(Budapest workshop on relativistic heavy ion collisions; Budapest (Hungary); 10-13 Aug 1992)			
	19:7719	*See* KFKI–1993-11/A			
CONF-920837–		(ICHEP-26: 26th International Union of Pure and Applied Physics (IUPAP) conference on high energy physics; Dallas, TX (United States); 6-12 Aug 1992)			
46	19:7344	*See* SLAC-PUB–5906			
CONF-9209427–		(Michigan Biotechnology Institute symposium; Grand Rapids, MI (United States); 10-15 Sep 1992)			
1-Rev.1	19:7463	*See* WSRC-MS–93-362-Rev.1			
CONF-9209428–		(23. general assembly of the European Seismological Commission; Prague (Czech Republic); 7-12 Sep 1992)			
	19:7444	*See* INIS-mf–13733			
	19:7446	*See* INIS-mf–13734			
CONF-9210176–		(63. shock and vibration symposium; Las Cruces, NM (United States); 27 Oct 1992)			
5	19:7186	*See* WAPD-T–2956			
CONF-9210313–		(Joint US/CERN school on particle accelerators frontiers of particle beams: factories with e^+e^- rings; Benalmadena (Spain); 28 Oct - 5 nov 1992)			
4	19:7224	*See* SLAC-PUB–6052			
CONF-9211117–		(Minerals, Metals, and Materials Society/American Society for Metals (TMS/ASM) materials week '92; Chicago, IL (United States); 2-5 Nov 1992)			
12	19:7001	*See* SAND–93-2168C			
CONF-921122–		(Meeting of the Division of Particles and Fields of the American Physical Society; Batavia, IL (United States); 10-14 Nov 1992)			
67	19:7345	*See* SLAC-PUB–5970			
CONF-9211277–		(6. IEA symposium on the aerodynamics of wind turbines; Petten (Netherlands); 30 Nov - 1 dec 1992)			
	19:6548	*See* ETSU-N–125			
CONF-9211278–		(American Society of Civil Engineers (ASCE) specialty conference on engineering survey for mega project-with-focus on SSC; Dallas, TX (United States); 10-14 Nov 1992)			
1	19:7277	*See* SLAC-PUB–5983			
CONF-9211282–		(SIRR congress; Rome (Italy); 22 Nov 1992)			
1	19:7314	*See* ETDE-IT–93-250			
CONF-9211284–		(American Nuclear Society winter meeting; Washington, DC (United States); Nov 1992)			
1	19:6744	*See* WAPD-T–2966			
CONF-9211286–		(3. European congress on technology assessment; Copenhagen (Denmark); 4-7 Nov 1992)			
Vol.1	19:6798	*See* NEI-DK–1373-Vol.1			
Vol.2	19:6799	*See* NEI-DK–1373-Vol.2			

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CONF-9212104–		(Understanding SMES technology, applications, and economics for end-use workshop; Atlanta, GA (United States); 2-3 Dec 1992)			
	19:6757	*See* ORNL/SUB–88-SM362/1			
CONF-9303220–		(Workshop on measurement quality assurance for ionizing radiation; Washington, DC (United States); 16-18 Mar 1993)			
3	19:7342	*See* PNL-SA–22101			
CONF-9303248–		(1993 Sanible symposia; St. Augustine, FL (United States); 15-19 Mar 1993)			
1	19:7936	*See* PNL-SA–21769			
CONF-930346–		(Optical Society of America meeting on optical remote sensing of the atmosphere; Salt Lake City, UT (United States); 8-12 Mar 1993)			
5	19:7352	*See* DOE/ER/61072–7			
CONF-930389–		(Future directions in particle and nuclear physics at multi-GeV hadron beam facilities; Upton, NY (United States); 4-6 Mar 1993)			
	19:7561	*See* BNL–52389			
CONF-930405–		(Spring meeting of the Materials Research Society; San Francisco, CA (United States); 12-16 Apr 1993)			
52	19:7046	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004738	MF-404
CONF-9304112–		(10. topical conference on radio frequency power in plasmas; Boston, MA (United States); 1-3 Apr 1993)			
24	19:7823	*See* GA-A–21286			
CONF-9304117–		(International waste management conference; San Juan (Puerto Rico); 28 Apr - 1 may 1993)			
5	19:6246	*See* WHC-SA–1907			
CONF-9304196–		(Austrian-Italian-Hungarian radiation protection symposium; Obergurgl (Austria); 28-30 Apr 1993)			
2	19:7313	*See* ETDE-IT–93-247			
CONF-930449–		(International workshop on physics and instrumentation at future linear colliders; Kona, HI (United States); 26-30 Apr 1993)			
8	19:7211	*See* SLAC-PUB–6313			
9	19:7227	*See* SLAC-PUB–6326			
10	19:7212	*See* SLAC-PUB–6334			
CONF-930484–		(11. Geothermal program review: geothermal energy - the environmentally responsible energy technology for the nineties; Berkeley, CA (United States); 27-29 Apr 1993)			
9	19:6501	*See* LBL–34774			
CONF-930511–		(PAC '93: international particle accelerator conference; Washington, DC (United States); 17-20 May 1993)			
495	19:7278	*See* SLAC-PUB–6167			
496	19:7279	*See* SLAC-PUB–6194			
499	19:7283	*See* SLAC-PUB–6296			
500	19:7239	*See* BNL–49648			
502	19:7215	*See* BNL–49312			
503	19:7208	*See* SLAC-PUB–6159			
504	19:7280	*See* SLAC-PUB–6201			
505	19:7225	*See* SLAC-PUB–6202			
506	19:7226	*See* SLAC-PUB–6204			
507	19:7281	*See* SLAC-PUB–6203			
CONF-9305136–		(International symposium on heavy ion fusion; Frascati (Italy); 25-28 May 1993)			
16	19:7886	*See* LBL–33798			
CONF-9305177–		(12. International collaboration of advanced neutron sources meeting (ICANS); Abingdon (United Kingdom); 24-28 May 1993)			
14	19:6322	*See* LA-UR–93-4257			
CONF-9305189–		(1993 joint Army, Navy, NASA, Air Force (JANNAF) Propulsion Systems Hazards Subcommittee meeting; Ft. Lewis, WA (United States); 10-14 May 1993)			
6	19:7369	*See* SAND–92-2662C			

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CONF-9305222–		(41. American Society of Mass Spectrometry conference on mass spectrometry and allied topics; San Francisco, CA (United States); 30 May - 4 jun 1993)			
3	19:7363	*See* Y/DK–977			
CONF-9305235–		(International workshop/time reversal invariance and parity violation in neutron physics; Dubna (Russian Federation); 4-7 May 1993)			
5	19:7592	*See* LA-UR–93-3920			
CONF-9305239–		(11. international workshop on electron resonance ion sources; Groningen (Netherlands); 5-8 May 1993)			
	19:7691	*See* CEA-CONF–11409			
CONF-9305267–		(International symposium on development and application of semiconductor tracking detectors; Hiroshima (Japan); 22-24 May 1993)			
2	19:7316	*See* FNAL/C–93/290-E			
CONF-9305282–		(Particle physics at the fermi scale workshop; Beijing (China); 27 May - 4 jun 1993)			
2	19:7690	*See* BNL–49626			
CONF-9305293–		(International symposium on nuclear structure physics today; Taiwan (China); 11-14 May 1993)			
3	19:7703	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002784	MF-412
CONF-9305305–		(GLAST silicon detector conference; Hiroshima (Japan): 22-24 May 1993)			
1	19:7346	*See* SLAC-PUB–6267			
CONF-9305309–		(16. meeting on elementary particle physics; Kazimierz (Poland); 24-28 May 1993)			
1	19:7548	*See* LA-UR–93-4173			
CONF-9305311–		(New physics in new experiments meeting; Kazimierz (Poland); May 1993)			
1	19:7628	*See* FNAL/C–93-329-E			
CONF-9305312–		(4. international conference on fundamentals of fracture; Urabandai (Japan); 30 May - 4 jun 1993)			
1	19:6989	*See* PNL-SA–21753			
CONF-9305314–		(2. two-arm photon spectrometer (TAPS) workshop; Guardamar (Spain); 31 May - 5 jun 1993)			
1	19:7673	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004795	MF-414
CONF-9305316–		(57. (spring 1993) meeting of Japan Thermal Spraying Society; Osaka (Japan); 19-20 May 1993)			
	19:7013	OSTI; NTIS; Availabel from Japan Thermal Spraying Society, 2-29, Eiwa 2-chome, Higashi-Osaka, Osaka, Japan		DE94731734	
CONF-9306134–		(Conference on hadron; Como (Italy); 21-25 Jun 1993)			
4	19:7625	*See* FNAL/C–93/313-E			
CONF-9306140–		(Coherent states: past present and future; Oak Ridge, TN (United States); 14-17 Jun 1993)			
2	19:7597	*See* DOE/ER/40291–20			
CONF-9306148–		(Coal-fired power systems '93: advances in IGCC and PFBC review meeting; Morgantown, WV (United States); 28-30 Jun 1993)			
	19:6067	*See* DOE/METC–93/6131			
CONF-9306176–		(Workshop on physics at current accelerators and the supercollider; Argonne, IL (United States); 2-5 Jun 1993)			
14	19:7610	*See* ANL-HEP-CP–93-95			
17	19:7317	*See* FNAL/C–93/302-E			
18	19:7609	*See* ANL-HEP-CP–93-52			
19	19:7611	*See* ANL-HEP-CP–93-99			
20	19:7654	*See* ANL-HEP-CP–93-94			
21	19:7347	*See* SLAC-PUB–6352			
22	19:7669	*See* SLAC-PUB–6354			
CONF-9306196–		(Les Houches Summer School of Theoretical Physics; Les Houches (France); 28 Jun - 30 jul 1993)			
1-Rev.	19:7179	*See* LBL–34124-Rev.			

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CONF-9306221--		(19 international conference on elastic and diffractive scattering (5th Blois workshop); Providence, RI (United States); 8-12 Jun 1993)			
9	19:7667	*See* SLAC-PUB-6340			
CONF-9306223--		(North Atlantic Treaty Organization (NATO) advanced study meeting of Institute on Nanophas Materials; Corfu (Greece); 20 Jun - 2 jul 1993)			
2	19:7061	*See* LBL-34763			
3	19:6929	*See* ANL/MSD/CP-79851			
CONF-9306245--		(North Atlantic Treaty Organization/Advanced Study Institute (NATO/ASI) conference on adaptive optics for astronomy; Cargese (France); 29 Jun - 9 aug 1993)			
2	19:7359	*See* UCRL-JC-115309			
CONF-9306251--		(Conference on physics in collision; Heidelberg (Germany); 16-18 Jun 1993)			
2	19:7668	*See* SLAC-PUB-6347			
CONF-9306258--		(Workshop on B physics at hadron colliders; Snowmass, CO (United States); 21 Jun - 2 jul 1993)			
8	19:7287	*See* SSCL-Preprint-520			
11	19:7228	*See* SLAC-PUB-6332			
13	19:7350	*See* SSCL-Preprint-535			
14	19:7349	*See* SSCL-Preprint-516			
CONF-9306260--		(Conference on exclusive reactions at high momentum transfer; Elba (Italy); 24-26 Jun 1993)			
2	19:7712	*See* DOE/ER/40427--15-N93			
3	19:7665	*See* SLAC-PUB-6316			
5	19:7656	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004244	MF-414
CONF-9306266--		(Global climate change; Washington, DC (United States); 10-11 Jun 1993)			
	19:7389	OSTI (Free of Charge)		TI94003319	MF-902
CONF-9306276--		(3. international workshop on a tau-charm factory; Marbella (Spain); 1-6 Jun 1993)			
1	19:7348	*See* SLAC-PUB-6376			
CONF-9306285--		(North Atlantic Treaty Organization/Advanced Study Institute (NATO/ASI) workshop in high performance computing in geosciences; Chamouix (France); 21-25 Jun 1993)			
1	19:7410	*See* LA-UR-93-4224			
CONF-9306287--		(Equation of state in astrophysics workshop; Saint-Malo (France); 14-18 Jun 1993)			
1	19:7560	*See* UCRL-JC-115702			
CONF-9306289--		(1993 American Society of Mechanical Engineers (ASME) pressure vessel and piping conference; New Orleans, LA (United States); 21-25 Jun 1993)			
1	19:7007	*See* WAPD-T-2973			
CONF-930635--		(Conference on optical spectroscopic instrumentation and techniques; Albuquerque, NM (United States); 3-6 Jun 1993)			
1	19:7282	*See* SLAC-PUB-6262			
CONF-930636--		(10. international conference on ultra-relativistic nucleus-nucleus collisions; Borlaenge (Sweden); 20-24 Jun 1993)			
9	19:7646	*See* LBL-34726			
10	19:7615	*See* BNL-49665			
11	19:7739	*See* UCRL-JC-112926			
CONF-930637--		(13. international conference on particles and nuclei; Perugia (Italy); 27 Jun - 3 jul 1993)			
11	19:7624	*See* FNAL/C-93/305			
12	19:7672	*See* BNL-49621			
13	19:7666	*See* SLAC-PUB-6329			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-930676--		(14. international conference of the International Association for the Advancement of High Pressure Science and Technology; Colorado Springs, CO (United States); 27 Jun - 2 jul 1993)			
55	19:7372	*See* UCRL-JC--113295			
CONF-930703--		(International cryogenic engineering conference and international cryogenic materials conference; Albuquerque, NM (United States); 12-16 Jul 1993)			
38	19:6978	*See* LBL--34019			
39	19:6977	*See* LBL--34018			
40	19:6976	*See* LBL--34017			
CONF-9307141--		(Mobile Analytical Laboratory workshop; Los Alamos, NM (United States); 20-21 Jul 1993)			
1	19:7430	OSTI; NTIS; GPO Dep.	E 1.99:	DE93040606	MF-902
CONF-9307143--		(5. international symposium on heavy flavor physics; Montreal (Canada); 6-10 Jul 1993)			
5	19:7296	*See* LBL--34556			
6	19:7629	*See* FNAL/C--93/330-E			
CONF-9307149--		(4. DOE Industry/University/Lab forum on robotics for environmental restoration and waste management; Albuquerque, NM (United States); 19-21 Jul 1993)			
Vugraphs	19:6286	*See* SAND--93-1888			
CONF-9307155--		(International school of physices on enrice fermi; Varenna (Italy); 20-30 Jul 1993)			
1	19:7191	*See* LBL--34433			
CONF-9307158--		(International conference on neutral currents twenty years later; Paris (France); 6-9 Jul 1993)			
1	19:7213	*See* SLAC-PUB--6355			
CONF-9307159--		(9. international conference on mathematical and computer modelling; Berkeley, CA (United States); 26-29 Jul 1993)			
1	19:7148	*See* PNL-SA--22415			
CONF-930722--		(Annual meeting of the Society of Photo-Optical Instrumentation Engineers (SPIE); San Diego, CA (United States); 11-16 Jul 1993)			
55	19:7351	*See* BNL--49632			
56	19:7210	*See* SLAC-PUB--6312			
CONF-930726--		(Windpower '93; San Francisco, CA (United States); 12-16 Jul 1993)			
7	19:6538	*See* PNL-SA--22124			
CONF-930749--		(34. annual meeting of the Institute of Nuclear Materials Management; Scottsdale, AZ (United States); 18-21 Jul 1993)			
	19:6144	*See* CEA-CONF--11609			
CONF-930761--		(International Europhysics conference on high-energy physics; Marseille (France); 22-28 Jul 1993)			
2	19:7651	*See* SLAC-PUB--6362			
3	19:7626	*See* FNAL/C--93/320-E			
4	19:7653	*See* ANL-HEP-CP--93-86			
5	19:7635	*See* FNAL/C--93/358-E			
6	19:7633	*See* FNAL/C--93/349-E			
CONF-930779--		(International cosmic-ray conference; Calgary (Canada); 19-20 Jul 1993)			
18	19:7649	*See* SLAC-PUB--6096			
CONF-930810--		(Topical meeting on environmental transport and dosimetry; Charleston, SC (United States); 31 Aug - 3 sep 1993)			
12	19:6187	*See* PNL-SA--21839			
13	19:7419	*See* PNL-SA--22351			
CONF-9308103--		(8. international electronic materials and processes congress; San Jose, CA (United States); 30 Aug - 2 sep 1993)			
1	19:6979	*See* LBL--34793			
CONF-9308109--		(7. American water jet technology conference; Seattle, WA (United States); 28-31 Aug 1993)			
2	19:6194	*See* PNL-SA--22721			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9308110--		(17. annual symposium of the Nuclear Information and Records Management Association; Augusta, GA (United States); 29 Aug - 2 sep 1993)			
2	19:6804	*See* PNL-SA-21958			
CONF-9308122--		(International Union of Materials Research Societies on advanced materials; Tokyo (Japan); 31 Aug - 4 sep 1993)			
12	19:6320	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001133	MF-404
17	19:7038	*See* SAND-93-2495C			
CONF-9308164--		(14. European conference on few-body problems in physics; Amsterdam (Netherlands); 22-27 Aug 1993)			
6	19:7613	*See* ANL/PHY/CP-80398			
7	19:7614	*See* BNL-49593			
CONF-9308168--		(International seminar on planetary emergencies; Erice (Italy); 19-24 Aug 1993)			
3	19:6172	*See* LA-UR-93-3077			
4	19:7202	*See* LBL-34722			
CONF-9308175--		(Latin American workshop on magnetism; Guanujuato (Mexico); 23-28 Aug 1993)			
2	19:7744	*See* LBL-34728			
CONF-9308178--		(Opportunities for HAR-MEMMS at Lawrence Berkeley Laboratory; Berkeley, CA (United States); 3 Aug 1993)			
	19:7147	*See* LBL-34767			
CONF-9308189--		(2. international conference on heat pumps in cold climates; Moncton (Canada); 16-17 Aug 1993)			
1	19:6842	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002440	MF-350
CONF-9308192--		(Real time applications of high performance computation for biological imaging; Urbana, IL (United States); Aug 1993)			
1	19:7490	*See* LA-UR-93-4210			
CONF-9308193--		(4. international conference on circulating fluidized beds; Champion, PA (United States); 1-5 Aug 1993)			
1	19:6068	*See* DOE/METC/C-93/7101			
CONF-9308195--		(International seminar on planetary emergencies; NATO workshop on global stability through disarmament; Erice (Italy); Erice (Italy); 19-24 Aug 1993; 19-23 aug 1993)			
1	19:7202	*See* LBL-34722			
CONF-9308199--		(23. summer school on nuclear physics; Piaski (Poland); 18-28 Aug 1993)			
1	19:7674	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004740	MF-413
CONF-9308201--		(1. summer school on neutron scattering; Zuoz (Switzerland); 15-21 Aug 1993)			
	19:7760	*See* PSI-PROC-93-01			
CONF-9308202--		(Formation, transport and consequences of particles in plasmas; Chateau de Bonas (France); 30 Aug - 3 sep 1993)			
	19:7832	*See* LRP-482/93			
CONF-9308204--		(International summer school on fundamentals of radiation damage; Urbana, IL (United States); 1-12 Aug 1993)			
1	19:7741	*See* PNL-SA-22813			
CONF-9308205--		(13. MAXENT workshop; Santa Barbara, CA (United States); 1-3 Aug 1993)			
1	19:7932	*See* LA-UR-93-4251			
CONF-9308206--		(International workshop on acceleration and radiation generation in space and laboratory plasmas; Kardmall (Greece); 10 Aug - 4 sep 1993)			
1	19:7550	*See* LA-UR-93-4262			
CONF-930823--		(16. international symposium on lepton and photon interactions; Ithaca, NY (United States); 10-15 Aug 1993)			
15	19:7650	*See* SLAC-PUB-6292			
16	19:7627	*See* FNAL/C-93/328			
17	19:7608	*See* SLAC-PUB-6384			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
18	19:7652	*See* SLAC-PUB–6378			
CONF-930824–		(Synchrotron radiation instrumentation; Gaithersburg, MD (United States); 23-26 Aug 1993)			
24	19:7271	*See* LBL–34670			
26	19:7272	*See* LBL–34730			
27	19:7270	*See* LBL–34603			
29	19:7289	*See* ANL/XFD/CP–81399			
30	19:7236	*See* ANL/XFD/CP–80249			
CONF-930825–		(6. international symposium on environmental degradation of materials in nuclear power systems: water reactors; San Diego, CA (United States); 3-5 Aug 1993)			
14	19:6987	*See* PNL-SA–21725			
15	19:6995	*See* PNL-SA–22941			
16	19:6988	*See* PNL-SA–21736			
CONF-930830–		(National conference and exposition on heat transfer; Atlanta, GA (United States); 8-11 Aug 1993)			
32	19:6484	*See* PNL-SA–21757			
CONF-930842–		(6. international conference on energy program evaluation: uses, methods and results; Chicago, IL (United States); 23-27 Aug 1993)			
4	19:6812	*See* PNL-SA–22175			
CONF-930867–		(Gull Lake nuclear physics conference on giant resonances; Gull Lake, MI (United States); 17-21 Aug 1993)			
2	19:7714	*See* DOE/ER/40537–31			
4	19:7704	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003473	MF-411
CONF-930893–		(Joint contractors meeting on advanced turbine systems, fuel cells and coal-fired heat; Morgantown, WV (United States); 3-5 Aug 1993)			
	19:6577	*See* DOE/METC–93/6132			
7	19:6573	*See* DOE/MC/23167–94/C0241			
17	19:6574	*See* DOE/MC/26041–94/C0256			
21	19:6571	*See* DOE/MC/23165–94/C0242			
22	19:6918	*See* DOE/MC/25124–94/C0245			
25	19:6916	*See* DOE/ER/81187–94/C0255			
26	19:6913	*See* DOE/MC/23174–94/C0246			
30	19:6069	*See* DOE/METC/C–94/7104			
37	19:6572	*See* DOE/MC/23166–94/C0236			
39	19:6578	*See* DOE/METC/C–94/7106			
40	19:6576	*See* DOE/MC/29061–94/C0239			
CONF-930895–		(International energy and environmental congress; Minneapolis, MN (United States); 4-5 Aug 1993)			
3	19:6856	*See* PNL-SA–22644			
CONF-930904–		(7. international conference on coal science; Banff (Canada); 12-17 Sep 1993)			
13	19:6042	*See* PNL-SA–22661			
14	19:6043	*See* PNL-SA–22667			
15	19:7123	*See* PNL-SA–22666			
CONF-930905–		(Actinides '93; Santa Fe, NM (United States); 19-24 Sep 1993)			
21	19:7133	*See* LA-UR–93-3281			
CONF-930906–		('93 international conference on nuclear waste management and environmental remediation; Prague (Czech Republic); 5-11 Sep 1993)			
16	19:6185	*See* PNL-SA–21257			
17	19:6188	*See* PNL-SA–22076			
18	19:6186	*See* PNL-SA–21411			
CONF-9309106–		(14. international symposium on materials science; Roskilde (Denmark); 6-10 Sep 1993)			
2	19:6840	*See* PNL-SA–22654			
CONF-9309111–		(10. annual international Pittsburgh coal conference: coal - energy and the environment; Pittsburgh, PA (United States); 20-24 Sep 1993)			
5	19:6017	*See* EGG-M–93358			

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CONF-9309119–		(9. biennial topical conference on atomic processes in plasmas; San Antonio, TX (United States); 19-23 Sep 1993)			
2	19:7885	*See* LA-UR–93-4482			
CONF-930914–		(The technical basis for measuring, modeling and mitigating toxic aerosols; Albuquerque, NM (United States); 26-30 Sep 1993)			
1	19:7423	*See* UCRL-JC–115045			
CONF-9309152–		(2. annual clean coal technology conference; Atlanta, GA (United States); 7-9 Sep 1993)			
1	19:6585	*See* DOE/PC/89651–T10			
CONF-9309168–		(2. international symposium on productive and quality improvement with a focus on government; Washington, DC (United States); 8-10 Sep 1993)			
3	19:7374	*See* PNL-SA–22307			
CONF-9309173–		(Capture gamma-ray symposium; Fribourg (Switzerland); 20-24 Sep 1993)			
7	19:7675	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003474	MF-413
8	19:7676	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004248	MF-414
CONF-9309188–		(Photovoltaic performance and reliability workshop; Golden, CO (United States); 8-10 Sep 1993)			
	19:6469	*See* NREL/CP–410-6033			
CONF-9309228–		(Focus 93: site characterization and model validation; Las Vegas, NV (United States); 26-29 Sep 1993)			
7	19:6201	*See* UCRL-JC–114791			
CONF-9309230–		(2. international workshop in integrating geographic information systems and environmental modeling; Breckenridge, CO (United States); 27-29 Sep 1993)			
3	19:7523	*See* UCRL-JC–112788			
CONF-9309231–		(International conference on textures of materials; Clausthal (Germany); 20-24 Sep 1993)			
6	19:6975	*See* LA-UR–93-4521			
CONF-9309256–		(3. London conference on position-sensitive detectors; London (United Kingdom); 6-10 Sep 1993)			
3	19:7300	*See* ANL/XFD/CP–80819			
CONF-9309257–		(Coal liquefaction and gas conversion contractor's review conference; Pittsburgh, PA (United States); 27-29 Sep 1993)			
1	19:6044	*See* SAND–93-1802C			
CONF-9309259–		(Nuclear instruments and methods in physics research on radiation effects in insulators; Nagoya (Japan); Sep 1993)			
2	19:7070	*See* PNL-SA–22525			
3	19:7083	*See* SAND–93-3826C			
4	19:7082	*See* SAND–93-3825C			
CONF-930926–		(13. international conference on magnet technology; Victoria (Canada); 20-24 Sep 1993)			
24	19:7269	*See* LBL–33440			
CONF-9309269–		(Department of Energy/National Renewable Energy Laboratory (DOE/NREL) ethanol project review meeting; Lakewood, CO (United States); 27-29 Sep 1993)			
1	19:7483	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001136	MF-401; MF-334
CONF-9309270–		(4. international symposium on the biological processing of fossil fuels; Alghero (Italy); 21-23 Sep 1993)			
1	19:6018	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001127	MF-108
CONF-9309278–		(International workshop on dynamical features of nuclei and finite fermi systems; Barcelona (Spain); 13-17 Sep 1993)			
1	19:7738	*See* LBL–34724			
CONF-9309279–		(Joint L+1 science review for USML-1 and USMP-1; Huntsville, AL (United States); 22-24 Sep 1993)			
1	19:7934	*See* LBL–34819			

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CONF-930928–		(6. international conference on fusion reactor materials; Stresa (Italy); 27 Sep - 1 oct 1993)			
11	19:7891	*See* PNL-SA–22489			
12	19:6990	*See* PNL-SA–22435			
15	19:7890	*See* PNL-SA–22470			
16	19:7892	*See* PNL-SA–22545			
17	19:6991	*See* PNL-SA–22442			
18	19:6994	*See* PNL-SA–22668			
19	19:7889	*See* PNL-SA–22456			
20	19:6992	*See* PNL-SA–22444			
21	19:6993	*See* PNL-SA–22526			
23	19:7893	*See* PNL-SA–23419			
CONF-9309285–		(International workshop on magnetic measurements of insertion devices; Argonne, IL (United States); 28-29 Sep 1993)			
	19:7230	*See* ANL/APS/TM–13			
CONF-9309288–		(Workshop on photocathodes for polarized electron sources for accelerators; Stanford, CA (United States); 8-10 Sep 1993)			
1	19:7284	*See* SLAC-PUB–6380			
CONF-9309289–		(International workshop on artificial intelligence applications in solar-terrestrial physics; Lund (Sweden); 22-24 Sep 1993)			
1	19:7549	*See* LA-UR–93-4185			
CONF-930929–		(7. international conference on emerging nuclear energy systems; Makuhari (Japan); 20-24 Sep 1993)			
1	19:7887	*See* LBL–34231			
CONF-9309290–		(4. international conference on x-ray microscopy; Chenogolovka (Russian Federation); 20-24 Sep 1993)			
1	19:7334	*See* LBL–34663			
CONF-9309292–		(Advanced study conference on heavy flavours; Pavia (Italy); 3-7 Sep 1993)			
1	19:7657	*See* FNAL/C–93/319-E			
2	19:7634	*See* FNAL/C–93/352-E			
3	19:7630	*See* FNAL/C–93/333			
CONF-9309296–		(Theory and phenomenology in astroparticle and underground physics conference; Gran Sasso (Italy); 19-23 Sep 1993)			
1	19:7686	*See* PNL-SA–22707			
CONF-9309297–		(23. international symposium on multiparticle dynamics; Aspen, CO (United States); 13-17 Sep 1993)			
1	19:7631	*See* FNAL/C–93.345-E			
2	19:7612	*See* ANL-HEP-CP–93-105			
CONF-9309298–		(Science with infrared surveys conference; Les Houches (France); 21-24 Sep 1993)			
1	19:7539	*See* FNAL/C–93/346			
CONF-9309302–		(Conference on many-body physics; Coimbra (Portugal); 20-25 Sep 1993)			
1	19:7599	*See* DOE/ER/40427–20-N93			
CONF-9309303–		(20. quantitative nondestructive evalution (QNDE) meeting; Brunswick, ME (United States); 1-6 Sep 1993)			
1	19:6927	*See* PNL-SA–22408			
CONF-9309304–		(17. International School of Theoretical Physics meeting on standard model and beyond; Krakow (Poland); Sep 1993)			
1	19:7536	*See* LA-UR–93-4316			
2	19:7593	*See* LA-UR–93-4315			
CONF-930935–		(7. American Society of Mechanical Engineers COGEN-TURBO power congress and exhibition; Bournemouth (United Kingdom); 21-23 Sep 1993)			
1	19:6758	*See* PNL-SA–21660			
CONF-930953–		(2. European conference on radiations and their effects on devices and systems; Saint Malo (France); 13-16 Sep 1993)			
2	19:7193	*See* SAND–93-1323C			

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CONF-930960–		(6. international conference on accelerator mass spectrometry; Canberra (Australia); 17 Sep - 1 oct 1993)			
4	19:7486	*See* UCRL-JC–113838			
5	19:7487	*See* UCRL-JC–115381			
6	19:7555	*See* LA-UR–93-4406			
7	19:7554	*See* LA-UR–93-4397			
CONF-930997–		(1. international symposium on structural intermetallics; Champion, PA (United States); 26-30 Sep 1993)			
7	19:7071	*See* PNL-SA–22561			
CONF-930999–		(NATO Advanced Study Institute on hot and dense nuclear matter; Bodrum (Turkey); 26 Sep - 9 oct 1993)			
2	19:7607	*See* LA-UR–93-4147			
3	19:7600	*See* DOE/ER/40427–21-N93			
4	19:7556	*See* LBL–34783			
CONF-931009–		(Fall meeting of the Minerals, Metals and Materials Society: physical metallurgy and materials; Pittsburgh, PA (United States); 17-21 Oct 1993)			
15	19:7787	*See* ANL/MSD/CP–81484			
16	19:7035	*See* PNL-SA–21630			
17	19:7005	*See* SAND–94-8475C			
CONF-9310100–		(Human Factors and Ergonomics Society meeting; Seattle, WA (United States); 11-15 Oct 1993)			
4	19:7939	*See* PNL-SA–23116			
5	19:7901	*See* PNL-SA–22737			
6	19:7106	*See* PNL-SA–22232			
7	19:7937	*See* PNL-SA–22009			
CONF-9310101–		(Asia and Pacific Basin Regional Congress on radiation protection; Beijing (China); 18-22 Oct 1993)			
2	19:7460	*See* UCRL-JC–113059			
CONF-9310102–		(4. energy natural phenomena hazards mitigation conference; Atlanta, GA (United States); 19-22 Oct 1993)			
36	19:6276	*See* LA-UR–93-3642			
38	19:7140	*See* BNL–49639			
40	19:6288	*See* UCRL-JC–115297			
CONF-931013–		(Conference on computation of electromagnetic fields; Miami, FL (United States); 31 Oct - 4 nov 1993)			
3	19:6915	*See* ANL/ET/CP–81277			
CONF-9310135–		(32. Hanford symposium on health and the environment; Richland, WA (United States); 18-21 Oct 1993)			
2	19:6293	*See* WHC-SA–1946			
3	19:6841	*See* ANL/DIS/CP–81461			
CONF-9310152–		(34. Association of Energy Systems, Operations and Programming forum; Seattle, WA (United States); 27-29 Oct 1993)			
2	19:7959	*See* PNL-SA–23053			
CONF-9310164–		(International symposium on substance identification technologies; Innsbruck (Austria); 4-8 Oct 1993)			
6	19:7327	*See* LA-UR–93-3588			
7	19:7326	*See* LA-UR–93-3528			
CONF-931018–		(Symposium on fusion engineering; Hyannis, MA (United States); 11-15 Oct 1993)			
44	19:7883	*See* LA-UR–93-3665			
48	19:7847	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002792	MF-420
61	19:7873	*See* GA-A–21485			
62	19:7874	*See* GA-A–21494			
63	19:7898	*See* UCRL-JC–115616			
64	19:7848	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003588	MF-420
65	19:7849	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003584	MF-420
67	19:7895	*See* SAND–93-2512C			
68	19:7882	*See* LA-UR–93-3655			
69	19:7881	*See* LA-UR–93-3647			

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70	19:7872	*See* GA-A–21445			
71	19:7871	*See* GA-A–21426			
72	19:7844	*See* ANL/EP/CP–79903			
73	19:7845	*See* ANL/EP/CP–79904			
74	19:7850	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004478	MF-420
76	19:7852	*See* DOE/ER/51124–13			
77	19:7884	*See* LA-UR–93-4234			
CONF-9310185–		(16. international meeting on reduced enrichment for research and test reactors (RERTR); Ibaraki (Japan); 3-7 Oct 1993)			
3	19:6685	*See* ANL/EP/CP–81419			
4	19:6688	*See* ANL/EP/CP–81464			
5	19:7688	*See* ANL/EP/CP–81421			
6	19:6686	*See* ANL/EP/CP–81422			
7	19:6687	*See* ANL/EP/CP–81441			
CONF-9310186–		(Environmental restoration on laser options; Atlanta, GA (United States); 24-28 Oct 1993)			
3	19:6294	*See* WHC-SA–2163			
CONF-9310193–		(CERN workshop on beam cooling and related topics; Geneva (Switzerland); 4-8 Oct 1993)			
6	19:7218	*See* FNAL/C–93/308			
8	19:7214	*See* BNL–48941			
9	19:7217	*See* BNL–49743			
10-Rev.	19:7216	*See* BNL–49554-Rev.			
CONF-9310196–		(1993 MATLAB conference; Boston, MA (United States); 18-20 Oct 1993)			
2	19:7149	*See* SAND–93-1298C			
CONF-9310204–		(Beam instrumentation workshop; Santa Fe, NM (United States); 20-23 Oct 1993)			
9	19:7231	*See* ANL/ASD/CP–80715			
10	19:7232	*See* ANL/ASD/CP–80718			
CONF-9310216–		(7. Deneb robotics user group meeting; Troy, MI (United States); 12-15 Oct 1993)			
4	19:7154	*See* SAND–93-2742C			
CONF-9310220–		(Institute of Electrical and Electronic Engineers (IEEE) meeting on scalable parallel libraries; Starkville, MS (United States); 6-8 Oct 1993)			
2	19:7944	*See* SAND–93-2595C			
3	19:7952	*See* UCRL-JC–115601			
4	19:7906	*See* ANL/MCS/CP–81643			
CONF-9310224–		(Materials Week '93; Pittsburgh, PA (United States); 17-21 Oct 1993)			
2	19:6996	*See* PNL-SA–23016			
CONF-931023–		(International conference on accelerator and large experimental control systems; Berlin (Germany); 18-22 Oct 1993)			
9	19:7931	*See* LA-UR–93-4102			
10	19:7273	*See* LBL–34776			
11	19:7235	*See* ANL/XFD/CP–79550			
CONF-9310231–		(2. ERS symposium on space at the service of our environment; Hamburg (Germany); 11-14 Oct 1993)			
1	19:7388	*See* BNL–49690			
CONF-9310232–		(Intel Super Computer Users Group meeting; St. Louis, MO (United States); 4 Oct 1993)			
1	19:7946	*See* SAND–93-2597C			
2	19:7945	*See* SAND–93-2596C			
CONF-9310234–		(International Association for Energy Economics North American conference; Seattle, WA (United States); 11-13 Oct 1993)			
2	19:6816	*See* PNL-SA–22894			
1-Vugraphs	19:6773	*See* PNL-SA–23122			
CONF-9310235–		(Integration algorithms for classical mechanics; Ontario (Canada); 14-27 Oct 1993)			
1	19:7930	*See* LA-UR–93-3914			
CONF-9310238–		(Institute of Electrical and Electronics Engineers (IEEE) bipolar/BiCMOS circuits and technology meeting; Minneapolis, MN (United States); 4-5 Oct 1993)			
1	19:7195	*See* SAND–93-1870C			

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CONF-9310239–		(3. annual conference on astronomical data analysis software and systems; Victoria (Canada); 13-15 Oct 1993)			
1	19:7354	*See* FNAL/C–93/339			
CONF-931024–		(184. meeting of the Electrochemical Society; New Orleans, LA (United States); 10-15 Oct 1993)			
1	19:6759	*See* ANL/CMT/CP–79723			
5	19:6760	*See* ANL/CMT/CP–79729			
CONF-9310240–		(20. annual meeting of the Federation of Analytical Chemistry and Spectroscopy Societies; Detroit, MI (United States); 17-22 Oct 1993)			
1	19:7107	*See* PNL-SA–22739			
CONF-9310242–		(18. annual conference of the Australian Radiation Protection Society; Sydney (Australia); 7 Oct 1993)			
1	19:7509	*See* UCRL-JC–115071			
2	19:7508	*See* UCRL-JC–115068			
CONF-9310246–		(1993 North American power symposium; Washington, DC (United States); 11-12 Oct 1993)			
1	19:6827	*See* PNL-SA–23064			
CONF-9310247–		(9. workshop on proton-antiproton collider physics; Tsukuba (Japan); 18-22 Oct 1993)			
1	19:7632	*See* FNAL/C–93/347-E			
2	19:7658	*See* FNAL/C–93/355-E			
3	19:7636	*See* FNAL/C–93/363-E			
CONF-9310250–		(LATTICE 93: international symposium on lattice field theory; Dallas, TX (United States); 12-17 Oct 1993)			
1	19:7594	*See* ANL-HEP-CP–93-98			
2	19:7750	*See* BNL–49782			
3	19:7655	*See* ANL-HEP-CP–93-102			
CONF-9310251–		(Interagency Advanced Power Group (IAPG) solar working group meeting; Denver, CO (United States); 18 Oct 1993)			
Summ.	19:6464	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004953	MF-220
CONF-9310252–		(BATSE gamma-ray burst workshop; Huntsville, AL (United States); 21-23 Oct 1993)			
1	19:7552	*See* LA-UR–93-4313			
2	19:7551	*See* LA-UR–93-4279			
4	19:7553	*See* LA-UR–93-4340			
CONF-931039–		(6. workshop on RF superconductivity; Newport News, VA (United States); 4-8 Oct 1993)			
3	19:7234	*See* ANL/PHY/CP–81316			
CONF-931043–		(8. symposium on separation science and technology for energy applications; Knoxville, TN (United States); 24-28 Oct 1993)			
6	19:6145	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003587	MF-940
7	19:6250	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004245	MF-902
8	19:7124	*See* PNL-SA–23135			
CONF-931051–		(Nuclear science symposium and medical imaging conference; San Francisco, CA (United States); 31 Oct - 6 nov 1993)			
1	19:6926	*See* PNL-SA–22406			
CONF-931054–		(25. Boulder damage symposium: annual symposium on optical materials for high-power lasers; Boulder, CO (United States); 27-29 Oct 1993)			
2	19:7085	*See* UCRL-JC–114841			
CONF-931076–		(Fall meeting of the Western States Section of the Combustion Institute; Menlo Park, CA (United States); 18-19 Oct 1993)			
4	19:7137	*See* UCRL-JC–115320			
CONF-931078–		(Mechanism and mechanics of composite fracture meeting; Pittsburgh, PA (United States); 17-21 Oct 1993)			
2	19:7084	*See* UCRL-JC–114725			
CONF-931079–		(Water reactor safety information meeting; Bethesda, MD (United States); 25-27 Oct 1993)			
9	19:6670	*See* SAND–93-1606C			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-931079–					
10	19:6707	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003583	
12	19:6738	*See* SAND–93-1498C			
13	19:6652	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003496	
14	19:6706	*See* BNL-NUREG–49711			
CONF-931094–		(12. coal gasification power plants conference; San Francisco, CA (United States); 27-29 Oct 1993)			
1	19:6569	*See* DOE/MC/21023–94/C0271			
CONF-931095–		(Department of Energy environmental remediation conference; Augusta, GA (United States); 24-28 Oct 1993)			
52	19:6272	*See* FEMP–2294			
59	19:6273	*See* FEMP–2310			
60	19:6274	*See* FEMP–2311			
63	19:6249	*See* ANL/EA/CP–79945			
64	19:6248	*See* ANL/EA/CP–79884			
65	19:7427	*See* ANL/EA/CP–79950			
67	19:6281	*See* PNL-SA–22357			
68	19:7457	*See* PNL-SA–22677			
70	19:6282	*See* PNL-SA–22393			
71	19:6190	*See* PNL-SA–22386			
74	19:6195	*See* PNL-SA–23141			
75	19:6192	*See* PNL-SA–22505			
76	19:6193	*See* PNL-SA–22649			
CONF-931107–		(1993 IEEE nuclear science symposium and medical imaging conference; San Francisco, CA (United States); 2-5 Nov 1993)			
13	19:7318	*See* FNAL/C–93/318			
15	19:7330	*See* LBL–33967			
16	19:7335	*See* LBL–34813			
17	19:7333	*See* LBL–34022			
18	19:7329	*See* LA-UR–93-3748			
19	19:7328	*See* LA-UR–93-3707			
22	19:6705	*See* BNL-NUREG–49671			
24	19:7331	*See* LBL–33991			
25	19:7190	*See* LBL–33594			
26	19:7740	*See* PNL-SA–22412			
27	19:7343	*See* PNL-SA–22411			
30	19:7337	*See* LBL–34899			
31	19:7285	*See* SLAC-PUB–6387			
CONF-931108–		(Fall meeting of the Materials Research Society (MRS); Boston, MA (United States); 29 Nov - 3 dec 1993)			
7	19:7074	*See* SAND–93-1453C			
8	19:6216	*See* WSRC-MS–93-529			
9	19:6974	*See* LA-UR–93-3981			
12	19:6176	*See* LA-UR–93-4161			
13	19:7358	*See* UCRL-JC–114506			
14	19:6931	*See* ANL/MSD/CP–80133			
15	19:6247	*See* ANL/CMT/CP–79780			
16	19:6932	*See* ANL/MSD/CP–80134			
18	19:7024	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004428	MF-401
19	19:6140	*See* ANL/CMT/CP–80026			
20	19:7077	*See* SAND–93-1529C			
21	19:6930	*See* ANL/MSD/CP–80132			
22	19:6139	*See* ANL/CMT/CP–80024			
24	19:7076	*See* SAND–93-1493C			
25	19:6199	*See* SAND–93-1272C			
26	19:7075	*See* SAND–93-1471C			
28	19:7194	*See* SAND–93-1509C			
29	19:7090	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004791	MF-411
31	19:7032	*See* LA-UR–93-4326			
33	19:7059	*See* LA-UR–93-4274			
35	19:7031	*See* LA-UR–93-4230			
36	19:7044	*See* ANL/MSD/CP–81580			
CONF-9311102–		(American Society for Precision Engineering (ASPE) conference; Seattle, WA (United States); 7-12 Nov 1993)			
5	19:7041	*See* UCRL-JC–113769			

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CONF-9311103–		(Institute of Electrical and Electronics Engineers (IEEE) and Tsukuba international workshop on advanced robotics; Tsukuba (Japan); 8-9 Nov 1993)			
2	19:7143	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003497	MF-406
CONF-9311104–		(40. national symposium of the American Vacuum Society (AVS); Orlando, FL (United States); 15-19 Nov 1993)			
7	19:6998	*See* SAND–93-1146C			
10	19:6999	*See* SAND–93-1171C			
13	19:7559	*See* UCRL-JC–115684			
14	19:7125	*See* SAND–93-1159C			
16	19:7749	*See* BNL–49777			
17	19:7043	*See* ANL/ET/CP–81579			
CONF-9311106–		(1993 Pacific Basin conference on hazardous waste; Honolulu, HI (United States); 8-12 Nov 1993)			
2	19:6189	*See* PNL-SA–22122			
CONF-9311114–		(Institute of Electrical and Electronic Engineers (IEEE) medical imaging conference; San Francisco, CA (United States); 4-6 Nov 1993)			
4	19:7495	*See* LBL–34512-Summ.			
5	19:6705	*See* BNL-NUREG–49671			
7	19:7331	*See* LBL–33991			
8	19:7190	*See* LBL–33594			
9	19:7332	*See* LBL–33998			
CONF-9311121–		(14. annual meeting of Institute of Nuclear Materials Management; Tokyo (Japan); 9-10 Nov 1993)			
1	19:6924	*See* SAND–93-2663C			
CONF-9311127–		(American Society of Mechanical Engineers (ASME) Eastern regional rotating machinery conference; Somerset, NJ (United States); 9-12 Nov 1993)			
1	19:6746	*See* WSRC-MS–93-084			
CONF-9311131–		(22. international thermal conductivity conference; Tempe, AZ (United States); 7-10 Nov 1993)			
1	19:6843	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003498	MF-350
2	19:7025	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004796	MF-364
CONF-9311132–		(American Society of Testing and Materials (ASTM) symposium; Williamsburg, VA (United States); 1-5 Nov 1993)			
1	19:6209	*See* WHC-SA–2180			
CONF-9311133–		(Advanced industrial hygiene and safety seminar; New Orleans, LA (United States); 9-11 Nov 1993)			
1	19:6295	*See* WHC-SA–2189			
CONF-9311135–		(Institute of Electrical and Electronic Engineers (IEEE) asilomar conference on signals, systems, and computers; Pacific Grove, CA (United States); 1-3 Nov 1993)			
1	19:7489	*See* LA-UR–93-4107			
2	19:7518	*See* LA-UR–93-3951			
3	19:6925	*See* LA-UR–93-4108			
4	19:7519	*See* LA-UR–93-4265			
CONF-9311138–		(NOVEL laser sources and applications workshop; San Jose, CA (United States); 12-13 Nov 1993)			
1	19:7196	*See* UCRL-JC–115682			
CONF-9311139–		(1993 symposium on nuclear data; Tokai (Japan); 18-19 Nov 1993)			
1	19:7705	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004246	MF-413
CONF-9311140–		(IAEA meeting on radio-frequency launchers for plasma heating and current drive; Naka (Japan); 10-12 Nov 1993)			
1	19:7796	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004243	MF-420
CONF-9311142–		(15. dry processing symposium; Tokyo (Japan); 1-2 Nov 1993)			
1	19:7080	*See* SAND–93-2678C			

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CONF-9311147–		(IAEA meeting on H-mode physics; Naka (Japan); 15-17 Nov 1993)			
1	19:7797	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004744	MF-427
2	19:7824	*See* GA-A–21507			
CONF-9311148–		(Military Operations Research Society (MORS) mini symposium on simulation data and its management; Falls Church, VA (United States); 16-18 Nov 1993)			
1	19:7954	*See* ANL/DIS/CP–81216			
CONF-931115–		(Supercomputing conference on high performance computing and communications; Portland, OR (United States); 15-19 Nov 1993)			
13	19:7950	*See* UCRL-JC–115318			
13-Rev.1	19:7951	*See* UCRL-JC–115318-Rev.1			
CONF-9311153–		(Materials Research Society meeting; Pittsburgh, PA (United States); 29 Nov - 3 dec 1993)			
1	19:7777	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004793	MF-423; MF-404
CONF-931116–		(Power-Gen Americas: 6th international power generation exhibition and conference; Dallas, TX (United States); 16-18 Nov 1993)			
1	19:6584	*See* ANL/ES/CP–81389			
CONF-931117–		(20. international technical meeting on air pollution modelling and its application; Valencia (Spain); 29 Nov - 3 dec 1993)			
1	19:7424	*See* UCRL-JC–115085			
CONF-931118–		(2. symposium on constraint effects in fracture; Fort Worth, TX (United States); 17-18 Nov 1993)			
1	19:6960	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004794	
CONF-931142–		(1. meeting of the Pacific Rim ceramic societies; Honolulu, HI (United States); 7-10 Nov 1993)			
2	19:7030	*See* LA-UR–93-3614			
CONF-931160–		(American Nuclear Society (ANS) winter meeting; San Francisco, CA (United States); 14-18 Nov 1993)			
33	19:6161	*See* FEMP–2297			
CONF-931168–		(3. Pacific Rim forum on composite materials: low-cost high-volume composite materials; Honolulu, HI (United States); 7-10 Nov 1993)			
2	19:7072	*See* SAND–93-0574C			
CONF-931195–		(International symposium on scientific basis for nuclear waste management; Boston, MA (United States); 29 Nov - 3 dec 1993)			
2	19:6191	*See* PNL-SA–22432			
CONF-931201–		(4. international conference on chemistry and migration behavior of actinides and fission products in the geosphere; Charleston, SC (United States); 12-17 Dec 1993)			
1	19:6138	*See* ANL/CMT/CP–79205			
3	19:7450	*See* LA-UR–93-3992			
7	19:7127	*See* SAND–93-7112C			
8	19:6242	*See* SAND–93-0429C			
10	19:6200	*See* SAND–93-7113C			
CONF-931215–		(International electron devices meeting; Washington, DC (United States); 5-8 Dec 1993)			
3	19:7198	*See* ANL/ASD/CP–81301			
CONF-931233–		(32. Institute of Electrical and Electronic Engineers (IEEE) conference on decision and control; San Antonio, TX (United States); Dec 1993)			
3	19:7938	*See* PNL-SA–22915			
CONF-931235–		(NASA 2003 conference; Anaheim, CA (United States); 7 Dec 1993)			
1	19:6883	*See* KCP–613-5310			
4	19:7036	*See* PNL-SA–23284			
CONF-931237–		(International conference on lasers and applications; Lake Tahoe, NV (United States); 6-10 Dec 1993)			
1	19:6207	*See* WHC-SA–2116			

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2	19:7237	*See* ANL/XFD/CP–81491			
CONF-931238–		(6. US-Japan workshop on superconductivity; Houston, TX (United States); 6-7 Dec 1993)			
1	19:7783	*See* ANL/ET/CP–81211			
2	19:7785	*See* ANL/ET/CP–81504			
3	19:7784	*See* ANL/ET/CP–81213			
CONF-931239–		(3. international SAMPE symposium on intermetallics; Chiba (Japan); 7-10 Dec 1993)			
1	19:6961	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004247	MF-310
CONF-931241–		(Pollution prevention technologies: industry exchange workshop; San Antonio, TX (United States); 1-3 Dec 1993)			
1	19:6897	*See* PNL-SA–23361			
CONF-940101–		(11. symposium on space nuclear power systems; Albuquerque, NM (United States); 9-13 Jan 1994)			
14	19:6632	*See* LA-UR–93-3595			
15	19:6634	*See* LA-UR–93-3726			
16	19:6633	*See* LA-UR–93-3651			
18	19:6635	*See* SAND–93-2296C			
20	19:6740	*See* SAND–93-2297C			
21	19:6636	*See* SAND–93-2696C			
27	19:7039	*See* SAND–93-2545C			
CONF-940109–		(International conference on reactor physics and reactor compuations; Tel Aviv (Israel); 23-26 Jan 1994)			
1	19:6175	*See* LA-UR–93-4093			
CONF-940115–		(74. American Meteorological Society annual meeting; Nashville, TN (United States); 23-28 Jan 1994)			
13	19:7387	*See* BNL–49231			
CONF-940121–		(Superconducting superlattices and multilayers and oxide superconductory physics and nanoengineering; Los Angeles, CA (United States); 23-28 Jan 1994)			
1	19:7786	*See* ANL/MSD/CP–80230			
CONF-940123–		(2. thematic conference on remote sensing for marine and coastal environments; New Orleans, LA (United States); 31 Jan - 2 feb 1994)			
1	19:7481	*See* SAND–93-2616C			
CONF-940136–		(27. Hawaii international conference on system sciences; Maui, HI (United States); 4-7 Jan 1994)			
1	19:7941	*See* SAND–93-2171C			
CONF-940142–		(OE/LASE '94: conference on optics, electro-optics, and laser applications in science and engineering; Los Angeles, CA (United States); 22-29 Jan 1994)			
1	19:7073	*See* SAND–93-0579C			
CONF-940143–		(Society of Photo-Optical Instrumentation Engineers (SPIE) conference on teleoperation and space telerobotics; Boston, MA (United States); 15 Jan 1994)			
1	19:6131	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003585	MF-526; MF-506
2	19:7144	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004739	MF-526
CONF-940144–		(20. annual Society of Explosives Engineers meeting on explosives and blasting techniques; Austin, TX (United States); 30 Jan - 2 feb 1994)			
2	19:7370	*See* SAND–93-2568C			
CONF-940146–		(12. international modal analysis conference; Honolulu, HI (United States); 31 Jan - 3 feb 1994)			
1	19:7150	*See* SAND–93-1419C			
CONF-940222–		(Corrosion 94: National Association of Corrosion Engineers (NACE) international annual conference; Baltimore, MD (United States); 28 Feb - 4 mar 1994)			
5	19:6215	*See* WSRC-MS–93-519			

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6	19:7002	*See* SAND–93-2205C			
7	19:6214	*See* WSRC-MS–93-518			
9	19:6997	*See* SAND–93-1099C			
CONF-940223–		(Vision science and its applications; Santa Fe, NM (United States); 11-15 Feb 1994)			
1	19:7514	*See* LA-UR–93-3283			
CONF-940235–		(International symposium on the physical metallurgy of zinc coated steels: processing, structure and properties; San Francisco, CA (United States); 28 Feb - 3 mar 1994)			
1	19:6980	*See* LBL–34795			
CONF-940301–		(207. spring national meeting of the American Chemical Society; San Diego, CA (United States); 13-18 Mar 1994)			
1	19:7079	*See* SAND–93-2542C			
2	19:7058	*See* LA-UR–93-3967			
3	19:6973	*See* LA-UR–93-3966			
4	19:7081	*See* SAND–93-2682C			
5	19:7126	*See* SAND–93-2514C			
CONF-940307–		(International symposium on nuclear material safeguards; Vienna (Austria); 14-18 Mar 1994)			
1	19:6306	*See* LA-UR–93-2783			
2	19:6307	*See* LA-UR–93-2784			
4	19:6311	*See* LA-UR–93-2862			
5	19:6309	*See* LA-UR–93-2860			
6	19:6310	*See* LA-UR–93-2861			
7	19:6308	*See* LA-UR–93-2848			
CONF-940312–		(2. Probabilistic safety assessment and management conference (PSAM); San Diego, CA (United States); 20-24 Mar 1994)			
1	19:6747	*See* WSRC-MS–93-353			
2	19:6702	*See* BNL-NUREG–48967			
3	19:6703	*See* BNL-NUREG–48994			
4	19:7367	*See* LA-UR–93-2080			
6	19:6298	*See* WSRC-MS–93-245			
7	19:6657	*See* LA-UR–93-3462			
8	19:6174	*See* LA-UR–93-3489			
9	19:6173	*See* LA-UR–93-3424			
10	19:6130	*See* WSRC-MS–93-336			
11	19:7953	*See* WSRC-MS–93-168			
12	19:7929	*See* LA-UR–93-3461			
13	19:6312	*See* LA-UR–93-3423			
14	19:6284	*See* RFP–4745			
15	19:6285	*See* RFP–4748			
15	19:6745	*See* WSRC-MS–92-475			
16	19:6735	*See* SAND–93-1321C			
17	19:7383	*See* UCRL-JC–115404			
18	19:7366	*See* UCRL-JC–112576			
19	19:6733	*See* SAND–93-1203C			
20	19:7902	*See* UCRL-JC–113553			
21	19:7382	*See* UCRL-JC–115269			
22	19:7943	*See* SAND–93-2420C			
23	19:6289	*See* UCRL-JC–115411			
24	19:7381	*See* UCRL-JC–114200			
25	19:7136	*See* UCRL-JC–113809			
26	19:7507	*See* RFP–4747			
27	19:7375	*See* SAND–93-1235C			
28	19:7159	*See* UCRL-JC–115410			
29	19:7942	*See* SAND–93-2419C			
30	19:6741	*See* SAND–93-2383C			
31	19:6599	*See* SAND–93-1092C			
32	19:7378	*See* SAND–93-2173C			
33	19:7376	*See* SAND–93-1236C			
34	19:6708	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002454	MF-411
35	19:6683	*See* LA-UR–93-3548			
36	19:6722	*See* LA-UR–93-3667			
37	19:6275	*See* LA-UR–93-3625			
38	19:7900	*See* LA-UR–93-3566			
39	19:6213	*See* WSRC-MS–93-470			
40	19:6277	*See* LA-UR–93-3666			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
41	19:6704	*See* BNL-NUREG–49610			
42	19:6739	*See* SAND–93-2218C			
43	19:6734	*See* SAND–93-1253C			
44	19:7365	*See* SAND–93-1256C			
45	19:7903	*See* UCRL-JC–115243			
47	19:7904	*See* UCRL-JC–115244			
CONF-940326–		(American Society of Mechanical Engineers (ASME) international solar energy conference; San Francisco, CA (United States); 27-30 Mar 1994)			
1	19:6529	*See* LA-UR–93-3695			
2	19:6491	*See* SAND–93-1533C			
3	19:6485	*See* SAND–93-2504C			
5	19:7003	*See* SAND–93-2334C			
CONF-940341–		(4. laser applications to chemical analysis meeting; Jackson Hole, WY (United States); 8-11 Mar 1994)			
1	19:7420	*See* SAND–93-2599C			
3	19:7104	*See* LA-UR–93-3930			
CWP–					
129P	19:7516	*See* DOE/ER/14079–29			
DESY–					
93-031	19:7292	OSTI; NTIS (US Sales Only); INIS		DE94734102	
93-051	19:7573	OSTI; NTIS (US Sales Only); INIS		DE94734103	
DOE-HMIP-RR–					
93.026	19:7435	OSTI; NTIS (US Sales Only); INIS		DE94610460	
DOE-STD–					
0101T	19:6719	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003651	MF-500
0103T	19:7899	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003653	MF-500
DOE/AL/31950–					
T8	19:6146	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005019	MF-903
DOE/AL/62350–					
0198-Rev.1	19:6257	*See* DOE/EIS–0198-Rev.1			
60F	19:6251	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004832	MF-902
68F-Rev.1	19:6252	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004834	MF-903
86D	19:6253	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004837	MF-902
88F	19:6254	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004839	MF-900; MF-907
DOE/BC/14886–					
4	19:6084	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003568	MF-122
DOE/BC/14958–					
4	19:6085	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003567	MF-122
DOE/BP–					
2008	19:6754	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003505	MF-920
2081	19:6751	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005637	MF-600
2119	19:6775	*See* DOE/EIS–0145-App.			
DOE/BP/21985–					
5	19:6461	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000948	MF-902
DOE/BP/35885–					
3	19:7482	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005630	MF-902
DOE/CE/23810–					
15	19:7047	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004959	MF-366
20D	19:7111	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003664	MF-350
22A	19:7048	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004236	MF-366
22B	19:7049	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004237	MF-366
22E	19:7390	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004906	MF-366
DOE/CH/10093–					
194	19:6064	OSTI; NTIS; GPO Dep.	E 1.99:	DE93000059	PC-321
206	19:6426	OSTI; NTIS; GPO Dep.	E 1.99:	DE93000081	MF-233
DOE/DP–					
0120	19:6132	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000997	MF-700
DOE/EA–					
0860	19:7431	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001262	MF-630
DOE/EE–					
0007	19:6917	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004709	MF-333; MF-334
0008	19:6844	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005264	MF-350
DOE/EH–					
0193P	19:6769	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005003	MF-600
0338T	19:6255	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000980	MF-630
0340	19:6256	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001560	MF-607

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/EH–					
0349	19:6147	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004708	MF-630
0352	19:6774	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94003881	MF-600
DOE/EIA–					
0095(92)	19:6568	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE94002519	MF-950
0109(93/12)	19:6097	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94004819	MF-950
0121(93/2Q)	19:6079	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94003694	MF-950
0130(93/12)	19:6116	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94004818	MF-950
0202(93/4Q)	19:6813	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94002854	MF-950
0226(93/10)	19:6755	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94002222	MF-950
0226(93/11)	19:6756	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94003906	MF-950
0226(93/12)	19:6823	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94004469	MF-950
0370(93)	19:6818	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94004648	MF-950
0436(93)	19:6643	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE94003847	MF-950
0464(91)	19:6828	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004426	MF-950
0520(93/11)	19:6098	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003616	MF-950
0520(93/12)	19:6099	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94004513	MF-950
0538(93/94-10)	19:6100	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004475	MF-950
0538(93/94-13)	19:6101	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005184	MF-950
0543(93/3Q)	19:6770	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004816	MF-950
0571	19:6819	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94002309	MF-950
0577(91)	19:6102	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE94004820	MF-950
M057	19:6766	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005135	MF-950
DOE/EIS–					
0145-App.	19:6775	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001269	MF-630
0158-FS	19:6105	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003608	MF-630
0159	19:6752	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003358	MF-630
0198-Rev.1	19:6257	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003177	MF-902
DOE/EM–					
0109P	19:6258	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002591	MF-902
94003781	19:6259	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003781	MF-900
DOE/ER–					
0597P	19:7515	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004710	MF-403
0597T	19:7391	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003150	PC-402
0607T	19:7562	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005376	MF-414
DOE/ER/00881–					
T3	19:7618	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001822	MF-414
T5	19:7619	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005596	MF-414
DOE/ER/10388–					
T1	19:7851	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003920	MF-420
DOE/ER/10629–					
T2	19:7302	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004872	MF-414
T3	19:7303	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004873	MF-414
T4	19:7620	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004874	MF-414
T5	19:7304	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004875	MF-414
T6	19:7305	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004876	MF-414
T7	19:7306	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004877	MF-414
T8	19:7307	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004878	MF-414
DOE/ER/12891–					
1	19:6122	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004842	MF-406
2	19:6123	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004843	MF-406
3	19:7189	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004844	MF-406
DOE/ER/12898–					
2	19:6601	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003522	MF-406; MF-404
DOE/ER/12983–					
1	19:6689	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004928	MF-406
DOE/ER/13528–					
7	19:7171	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004172	MF-406
DOE/ER/13538–					
8	19:7112	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004412	MF-401
DOE/ER/13552–					
10	19:7091	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004162	MF-401
DOE/ER/13564–					
12	19:7113	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004168	MF-401
DOE/ER/13775–					
5	19:7114	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004963	MF-401
DOE/ER/13823–					
T2	19:7092	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004399	MF-406
DOE/ER/13839–					
T2	19:7172	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003320	MF-406

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/ER/13844–T1	19:7746	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003948	MF-411
DOE/ER/13849–5	19:7747	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005414	MF-401
DOE/ER/14017–5	19:7789	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003400	MF-411
DOE/ER/14079–29	19:7516	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003394	MF-403
DOE/ER/14104–4	19:7050	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004169	MF-404
DOE/ER/14105–4	19:7128	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004958	MF-401
DOE/ER/14113–3	19:7517	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003520	MF-403
DOE/ER/14165–T1	19:7115	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004402	MF-401
DOE/ER/14221–3	19:6091	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005602	MF-401
DOE/ER/14320–1	19:7093	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004564	MF-401
DOE/ER/25053–T2	19:7908	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005133	MF-405
DOE/ER/25100–2	19:7909	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003982	MF-405
DOE/ER/25118–1	19:7910	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003918	MF-405
DOE/ER/25137–1	19:7911	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001882	MF-405
DOE/ER/40272–194	19:7563	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004373	MF-414
DOE/ER/40281–8	19:7706	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004701	MF-414
DOE/ER/40291–20	19:7597	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005417	MF-414
DOE/ER/40314–7	19:7670	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004414	MF-413
DOE/ER/40316–7	19:7707	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001309	MF-413
DOE/ER/40342–6	19:7708	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004851	MF-413
DOE/ER/40374–73	19:7197	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005162	MF-414
DOE/ER/40402–6	19:7709	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001585	MF-413
DOE/ER/40404–5	19:7710	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004716	MF-413
DOE/ER/40406–6	19:7677	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004715	MF-413
DOE/ER/40412–T3	19:7598	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004409	MF-414
DOE/ER/40414–6	19:7711	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004642	MF-413
DOE/ER/40425–258	19:7671	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004962	MF-413
DOE/ER/40427–15-N93	19:7712	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002725	MF-413
20-N93	19:7599	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004646	MF-413
21-N93	19:7600	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004645	MF-413
DOE/ER/40442–6	19:7713	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002470	MF-413
DOE/ER/40445–43	19:7621	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004640	MF-413
DOE/ER/40448–6	19:7564	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004161	MF-413
DOE/ER/40452–9	19:7308	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002417	MF-412
DOE/ER/40503–T1	19:7309	OSTI; NTIS; GPO Dep.	E 1.99:	DE93018898	MF-406
DOE/ER/40537–31	19:7714	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002317	MF-413

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/ER/40576–					
T1	19:7260	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002766	MF-406
DOE/ER/40592–					
3	19:7601	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004418	MF-413
DOE/ER/40627–					
3	19:7565	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004238	MF-414
DOE/ER/40654–					
3	19:7622	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002406	MF-414
DOE/ER/40661–					
5	19:7566	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000961	MF-414
DOE/ER/40665–					
T2	19:7567	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004407	MF-414
DOE/ER/40673–					
2	19:7310	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002901	MF-414
DOE/ER/40677–					
2-Pt.1	19:7568	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004955	MF-414
2-Pt.2	19:7569	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004956	MF-414
DOE/ER/40685–					
759	19:7623	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002310	MF-414
DOE/ER/40688–					
2	19:7311	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002156	MF-414
DOE/ER/40692–					
2	19:7715	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003161	MF-414
DOE/ER/40756–					
1	19:7716	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004177	MF-413
DOE/ER/40787–					
1	19:7312	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001655	MF-411
DOE/ER/45184–					
9	19:6962	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003159	MF-404
DOE/ER/45503–					
1	19:7116	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004960	MF-404
DOE/ER/51124–					
13	19:7852	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004965	MF-427
DOE/ER/52111–					
6	19:7853	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004411	MF-420
DOE/ER/52158–					
11	19:7854	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003162	MF-424
DOE/ER/53198–					
227	19:7798	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003846	PC-426
229	19:7799	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005459	PC-426
230	19:7800	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005543	PC-426
231	19:7801	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005542	PC-426
DOE/ER/53211–					
12	19:7802	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002316	MF-420
DOE/ER/53212–					
T2	19:7803	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005409	MF-427
DOE/ER/53222–					
108	19:7804	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003317	PC-426
DOE/ER/53237–					
T1	19:7805	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004400	MF-426
DOE/ER/53281–					
T1	19:7806	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004907	MF-426
T2	19:7807	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005149	MF-426
T3	19:7808	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005150	MF-426
DOE/ER/53291–					
225	19:7809	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001785	PC-427
DOE/ER/54111–					
3	19:7810	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003391	MF-420
DOE/ER/54139–					
2	19:7811	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004166	MF-420
DOE/ER/54196–					
1	19:7812	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004699	MF-427
DOE/ER/54197–					
1	19:7813	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003533	MF-420
DOE/ER/60437–					
8	19:7752	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003068	MF-410
DOE/ER/60581–					
6	19:7432	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001797	MF-402
DOE/ER/60844–					
1	19:7117	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005134	MF-403
3	19:7433	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003983	MF-403

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/ER/60848–					
3	19:7496	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001645	MF-408
DOE/ER/60991–					
T3	19:6260	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004417	MF-408; MF-721; MF-401
DOE/ER/61010–					
T10	19:7393	OSTI; NTIS; GPO Dep.	E 1.99:	DE93040796	MF-402
T24	19:6776	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003830	MF-402
T9	19:7392	OSTI; NTIS; GPO Dep.	E 1.99:	DE93040720	MF-402
DOE/ER/61054–					
3	19:7467	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000780	MF-402
DOE/ER/61059–					
2	19:7394	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003523	MF-402
DOE/ER/61065–					
3	19:7395	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000432	MF-402
DOE/ER/61072–					
7	19:7352	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001878	MF-402
DOE/ER/61256–					
T2	19:7488	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005412	MF-408
DOE/ER/61365–					
T2	19:7396	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000960	MF-402
DOE/ER/61403–					
2	19:7051	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000963	MF-403; MF-406
DOE/ER/61443–					
2	19:7353	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003399	MF-406
DOE/ER/61540–					
1	19:7468	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001787	MF-402
DOE/ER/75531–					
1	19:7538	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004406	MF-410
DOE/ER/75640–					
1	19:6910	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004925	MF-400
DOE/ER/81187–					
94/C0255	19:6916	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002787	MF-106; MF-111
DOE/ET/10815–					
208	19:6834	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003126	MF-112
DOE/ET/53088–					
623-Rev.	19:7814	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003511	MF-420
627	19:7815	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003119	MF-420
629	19:7816	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003120	MF-426
632	19:7817	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003510	MF-420
T4	19:7818	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003135	MF-421
DOE/EV/03688–					
T3	19:7397	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE93017968	MF-902
DOE/EW/50625–					
T10	19:6779	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004503	MF-902
T11	19:6263	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004502	MF-902
T12	19:6234	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004501	MF-902
T13	19:7511	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004493	MF-902
T2	19:6261	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004511	MF-902
T3	19:7492	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004510	MF-902
T4	19:6262	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004509	MF-902
T5	19:6777	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004508	MF-902
T7	19:7469	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004506	MF-902
T9	19:6778	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004504	MF-902
DOE/EW/53023–					
T3	19:7470	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002242	MF-902
DOE/FTR–					
93016208	19:6824	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93016208	MF-223
93017127	19:6302	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93017127	MF-706
93017643	19:7398	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93017643	MF-402
93017644	19:7385	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93017644	MF-101; MF-105
93017803	19:7819	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93017803	MF-424
93017868	19:6709	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93017868	MF-520
93018043	19:7524	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018043	MF-413
93018044	19:7855	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018044	MF-420
93018045	19:6019	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018045	MF-108
93018109	19:7094	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018109	MF-410

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
93018110	19:6133	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018110	MF-701
93018121	19:6363	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018121	MF-241
93018122	19:6830	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018122	MF-201; MF-220
93018123	19:7856	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018123	MF-712
93018125	19:6148	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018125	MF-900
93018126	19:6149	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018126	MF-900
93018178	19:6780	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018178	MF-902
93018254	19:6963	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018254	MF-404
93018257	19:7857	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018257	MF-420
93018258	19:6710	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018258	MF-520
93018325	19:6761	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018325	MF-331
93018326	19:7858	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018326	MF-712
93018328	19:7859	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018328	MF-422
93018329	19:7860	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018329	MF-421
93018330	19:6762	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018330	MF-212
93018607	19:7861	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018607	MF-420
93018611	19:6625	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018611	MF-520
93018612	19:6711	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018612	MF-530
93018760	19:6150	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018760	MF-902
93018761	19:7862	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018761	MF-421
93018762	19:7434	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018762	MF-502
93018764	19:7052	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018764	MF-274
93018765	19:7863	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018765	MF-421
93018766	19:7912	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018766	MF-706
93019137	19:7864	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93019137	MF-420
93019276	19:7053	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93019276	MF-700; MF-704
93019285	19:7865	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93019285	MF-420
93040088	19:7820	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93040088	MF-420
94000750	19:6466	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000750	MF-270
94000755	19:6845	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000755	MF-232
94000999	19:7753	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000999	MF-411
94001285	19:7866	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94001285	MF-700
94001286	19:6264	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94001286	MF-721
94001874	19:7026	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94001874	MF-411
94001875	19:7867	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94001875	MF-420
94001876	19:7868	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94001876	MF-423
94002462	19:7751	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002462	MF-406
94002464	19:6763	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002464	MF-212
94002465	19:6542	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002465	MF-261
94002467	19:7821	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002467	MF-420
94002468	19:7200	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002468	MF-414
94002475	19:6712	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002475	MF-702
94002747	19:7869	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002747	MF-700
94002802	19:6151	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002802	MF-520
94002828	19:7373	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002828	MF-741
94004045	19:6065	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004045	MF-106
94004453	19:6479	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004453	MF-274
94004857	19:6364	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004857	MF-245
94004970	19:7870	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004970	MF-426
DOE/HWP–					
147	19:7399	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005146	MF-902
DOE/ID–					
10253-FY93	19:6265	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE93016684	MF-900
DOE/ID/12692–					
4	19:6868	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000365	PC-310
DOE/ID/12735–					
T28	19:6835	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003657	MF-112
DOE/IG–					
0336	19:7201	OSTI (Free of Charge)		TI94003501	PC-960
0337	19:6303	OSTI (Free of Charge)		TI94003515	PC-960
DOE/LLW–					
99	19:6152	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005183	MF-940
DOE/LM–					
0001	19:6795	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003860	MF-900
DOE/MC/11076–					
3539	19:6113	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000065	MF-121
3554	19:6045	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000079	PC-132
DOE/MC/21023–					
3525	19:6570	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000050	MF-103

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94/C0271	19:6569	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002959	MF-103
DOE/MC/23165–					
94/C0242	19:6571	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002969	MF-111
DOE/MC/23166–					
94/C0236	19:6572	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003193	MF-111
DOE/MC/23167–					
94/C0241	19:6573	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001922	MF-103; MF-111
DOE/MC/23174–					
3490	19:6066	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000023	PC-111
94/C0246	19:6913	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002972	MF-111
DOE/MC/24257–					
3499	19:6020	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000031	MF-103; MF-111
DOE/MC/25003–					
3495	19:6021	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000028	PC-106
DOE/MC/25124–					
94/C0245	19:6918	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002971	MF-111
DOE/MC/26024–					
3528	19:6115	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000053	PC-132
DOE/MC/26031–					
3462	19:6086	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000003	MF-122
DOE/MC/26041–					
3533	19:6575	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000058	PC-111
94/C0256	19:6574	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002965	MF-106; MF-111
DOE/MC/27225–					
3540	19:6325	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000066	MF-108
DOE/MC/27226–					
3568	19:6022	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005302	MF-109
DOE/MC/27246–					
3480	19:6119	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002824	MF-123
DOE/MC/29061–					
94/C0239	19:6576	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003194	MF-111
DOE/MC/29119–					
3524	19:7436	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000049	MF-906
DOE/MC/29227–					
3510	19:6836	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000040	MF-110
3511	19:6837	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000041	MF-110
DOE/MC/30098–					
3552	19:6046	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000077	PC-109
DOE/METC–					
93/6131	19:6067	OSTI; NTIS; GPO Dep.	E 1.99:	DE93000289	MF-102; MF-106; MF-107
93/6132	19:6577	OSTI; NTIS; GPO Dep.	E 1.99:	DE93011308	MF-110; MF-111
DOE/METC/C–					
93/7101	19:6068	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003921	MF-103
94/7104	19:6069	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002977	MF-111
94/7106	19:6578	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002975	MF-104; MF-111
DOE/MT/92001–					
4	19:6106	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003278	MF-122
DOE/MT/92009–					
4	19:6104	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003562	MF-122
DOE/NE/32170–					
23	19:6629	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001646	MF-528
DOE/NV/10630–					
66-Vol.1	19:7437	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003235	MF-702
66-Vol.2	19:7438	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003236	MF-702
DOE/NV/11417–					
1	19:6153	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004562	MF-814
2	19:6154	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004563	MF-814
DOE/OR/00033–					
T543	19:7439	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000837	MF-402
T554	19:7400	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000848	MF-402
T555	19:7440	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000849	MF-602
T564	19:7754	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001407	MF-420
T565	19:7822	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001408	MF-420
T566	19:7471	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001409	MF-408

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T568	19:7472	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001411	MF-408
T569	19:7441	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001412	MF-402
T572	19:6637	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001415	MF-406; MF-405
DOE/PC/79867–					
T1	19:6009	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003776	MF-102
T1-App.	19:6010	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003845	MF-102
DOE/PC/88879–					
T7	19:6011	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004514	PC-113
DOE/PC/89651–					
T10	19:6585	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001957	MF-105
T11	19:6586	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005036	MF-105
DOE/PC/89655–					
T9	19:6587	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004550	MF-105
DOE/PC/89658–					
T6	19:6056	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004516	MF-102
DOE/PC/89659–					
T14	19:6588	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003600	MF-105
DOE/PC/89663–					
T10	19:6047	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003598	MF-113
DOE/PC/89775–					
14	19:6023	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003573	MF-102
DOE/PC/89883–					
76	19:6048	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005042	MF-108
78	19:6049	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005041	MF-108
DOE/PC/90042–					
T4	19:6454	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004520	MF-108
T6	19:6024	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004537	MF-108
T7	19:6455	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005034	MF-108
DOE/PC/90046–					
T4	19:6456	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002160	MF-108
T7	19:6025	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003337	MF-108
DOE/PC/90055–					
T10	19:6029	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005029	MF-108
T11	19:6030	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005030	MF-108
T7	19:6026	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005026	MF-108
T8	19:6027	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005027	MF-108
T9	19:6028	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005028	MF-108
DOE/PC/90182–					
T11	19:6062	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005033	MF-117
DOE/PC/90285–					
T10	19:6070	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001980	MF-104
DOE/PC/90287–					
T12	19:6012	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004525	MF-102
DOE/PC/90290–					
12	19:6050	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002670	MF-102
13	19:6051	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003521	MF-102
DOE/PC/90299–					
T12	19:6057	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005044	MF-105
DOE/PC/90304–					
T5	19:6031	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002659	MF-108
DOE/PC/90310–					
T13	19:6071	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002656	MF-113
DOE/PC/90361–					
T11	19:6589	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001660	MF-105
DOE/PC/90546–					
T10	19:6590	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002403	MF-105
T11	19:6591	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005048	MF-105
T9	19:6058	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002404	MF-105
DOE/PC/91028–					
T7	19:6457	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003301	MF-108
DOE/PC/91030–					
T6	19:7118	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004732	MF-132
DOE/PC/91040–					
29	19:6032	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005040	MF-108
DOE/PC/91042–					
6	19:6033	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003308	MF-108
DOE/PC/91053–					
T5	19:6034	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003304	MF-108
DOE/PC/91161–					
T6	19:7145	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003289	MF-104

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DOE/PC/91280–					
T9	19:6013	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001981	MF-102
DOE/PC/91286–					
T8	19:6035	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005047	MF-109
DOE/PC/91297–					
T3	19:6063	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005046	MF-117
DOE/PC/91301–					
8	19:6458	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003572	MF-102
DOE/PC/91304–					
T7	19:6036	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004546	MF-108
DOE/PC/91305–					
8	19:6052	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005043	MF-102
DOE/PC/91308–					
7	19:6072	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001958	MF-104
DOE/PC/91346–					
3	19:6592	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002151	MF-105
DOE/PC/92108–					
T3	19:6037	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004528	MF-108
DOE/PC/92152–					
T4	19:7173	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004522	MF-104
DOE/PC/92162–					
T1	19:6073	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001983	MF-113
T2	19:6074	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003234	MF-113
DOE/PC/92176–					
T3	19:6075	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002175	MF-113
DOE/PC/92206–					
T2	19:6014	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003300	MF-102
DOE/PC/92527–					
T3	19:6038	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001968	MF-108
DOE/PC/92528–					
4	19:6076	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004541	MF-104
DOE/PC/92544–					
5	19:6053	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005023	MF-113
DOE/PC/92546–					
T4	19:6015	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003630	MF-102
DOE/PC/92547–					
T2	19:6016	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003288	MF-114
DOE/PC/92548–					
T4	19:6077	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005045	MF-105
DOE/PN/38195–					
T1	19:7174	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004430	MF-506
DOE/PO–					
0008	19:6869	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005000	MF-900
DOE/RL–					
89-12-Rev.1	19:7442	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005512	MF-902
92-46	19:6266	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003905	MF-630
93-04	19:6267	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004483	MF-902
93-75	19:6268	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004821	MF-630; MF-721
93-85	19:6109	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004482	MF-900
93-89	19:6269	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004488	MF-902
93-90	19:6304	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004896	MF-900
93-97	19:6155	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005257	MF-630
DOE/RL/01830–					
H15	19:6270	OSTI; NTIS; GPO Dep.	E 1.99:	DE93019843	MF-602
DOE/RL/12092–					
T1	19:7401	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000567	MF-402; MF-406
DOE/S–					
0106P	19:6765	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003679	PC-960
DOE/SF/16564–					
T4-Vol.1	19:6713	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005054	MF-523
T4-Vol.2	19:6714	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005055	MF-523
T4-Vol.3	19:6715	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005056	MF-523
T4-Vol.4	19:6716	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005057	MF-523
T4-Vol.6	19:6717	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005059	MF-523
T4-Vol.7	19:6718	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005060	MF-523
DOE/SF/19441–					
T5	19:6630	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94001890	MF-528
T6	19:6631	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002017	MF-528

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/SF/19681–					
T2	19:6595	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000535	MF-523
DOE/WIPP–					
91-047C	19:6235	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003900	MF-903
93-004	19:6156	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003508	MF-902
DPSP–					
54-1-5-Del.Ver.	19:6690	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93016028	MF-700
54-1-6-Del.Ver.	19:6691	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93016027	MF-700
54-1-7-Del.Ver.	19:6692	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93016029	MF-700
DPSZ–					
7890	19:7364	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93015772	MF-706
DTH-ISVA-PR–					
73	19:7175	OSTI; NTIS		DE94730211	
DTH-LBM-TR–					
92-266	19:6593	OSTI; NTIS		DE94730340	
DTH-LV-MEDD–					
227	19:6964	OSTI; NTIS		DE94730212	
241	19:6846	OSTI; NTIS		DE94730341	
DUN–					
5558-RD	19:6693	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003748	MF-520
ECN-C–					
93-062	19:7913	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729856	
93-064	19:6060	OSTI; NTIS; INIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729857	
93-072	19:6543	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729864	
93-078	19:6544	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729859	
93-079	19:6545	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729858	
ECN-I–					
93-036	19:6546	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729861	
93-038	19:6870	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729862	
ECN-R–					
93-005	19:6547	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729810	
ECN-RX–					
93-099	19:6467	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729850	
93-100	19:6468	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729849	
93-103	19:6567	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729851	
93-105	19:6838	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729809	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
93-106	19:7027	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729852	
93-107	19:7402	OSTI; NTIS; Available from the library of the Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG Petten (Netherlands)		DE94729808	
EDF–					
93-NB-00086	19:6579	OSTI; NTIS (US Sales Only)		DE94728745	
93-NB-00101	19:6580	OSTI; NTIS (US Sales Only)		DE94728749	
93-NM-00022	19:6871	OSTI; NTIS (US Sales Only)		DE94728743	
93-NM-00028	19:6326	OSTI; NTIS (US Sales Only)		DE94728744	
EGG–					
11265-1009	19:6236	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004711	MF-702
2679(92)	19:6157	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002898	MF-902; MF-940
2689	19:6728	*See* NUREG/CR–5949			
EGG-M–					
93358	19:6017	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002895	MF-102
EGG-RAAM–					
10741	19:6158	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002896	MF-940; MF-905
EGG-WTD–					
10766	19:6159	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002861	MF-940
10875	19:6271	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002846	MF-940
EML–					
557	19:7443	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003691	MF-402
ENEA-RT-AMB–					
91-18	19:7403	OSTI; NTIS (US Sales Only)		DE94727313	
92-03	19:6160	OSTI; NTIS (US Sales Only)		DE94727330	
92-04	19:6581	OSTI; NTIS (US Sales Only)		DE94727344	
92-08	19:7473	OSTI; NTIS (US Sales Only)		DE94727309	
92-11	19:7404	OSTI; NTIS (US Sales Only)		DE94727312	
92-12	19:7501	OSTI; NTIS (US Sales Only)		DE94727343	
ENEA-RT-ENERG–					
92-01	19:6480	OSTI; NTIS (US Sales Only)		DE94727310	
92-02	19:6898	OSTI; NTIS (US Sales Only)		DE94727311	
ESTSC–					
000597IBMPC02	19:7914	ESTSC			
000635IBMPC00	19:7915	ESTSC			
000644AL00000	19:7916	ESTSC			
ESTSC/NRC/R–					
000098C017600	19:7917	ESTSC			
000316IBMPC00	19:7918	ESTSC			
000322I037000	19:7919	ESTSC			
000372IBMPC00	19:7920	ESTSC			
ETDE-GB–					
528	19:6872	OSTI; NTIS (US Sales Only)		DE94730985	
529	19:6873	OSTI; NTIS (US Sales Only)		DE94730986	
530	19:6874	OSTI; NTIS (US Sales Only)		DE94730987	
531	19:6875	OSTI; NTIS (US Sales Only)		DE94730988	
532	19:6876	OSTI; NTIS (US Sales Only)		DE94730989	
533	19:6877	OSTI; NTIS (US Sales Only)		DE94730990	
534	19:6911	OSTI; NTIS (US Sales Only)		DE94730991	
535	19:6878	OSTI; NTIS (US Sales Only)		DE94730992	
536	19:6879	OSTI; NTIS (US Sales Only)		DE94730993	
537	19:6880	OSTI; NTIS (US Sales Only)		DE94730994	
ETDE-IT–					
93-247	19:7313	OSTI; NTIS (US Sales Only)		DE94727314	
93-248	19:6781	OSTI; NTIS (US Sales Only)		DE94727342	
93-249	19:7405	OSTI; NTIS (US Sales Only)		DE94727351	
93-250	19:7314	OSTI; NTIS (US Sales Only)		DE94727364	
ETDE/JP-mf–					
94732332	19:6495	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732332	
94732333	19:6496	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732333	

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94732334	19:6500	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732334	
ETSU-B/B–					
3/00242/REP	19:6365	OSTI; NTIS (US Sales Only)		DE94730466	
ETSU-B/T–					
1/00207/REP	19:6366	OSTI; NTIS (US Sales Only)		DE94726335	
ETSU-B/W–					
5/00340/REP	19:6445	OSTI; NTIS (US Sales Only); INIS		DE94730468	
ETSU-N–					
125	19:6548	OSTI; NTIS (US Sales Only)		DE94725270	
ETSU-R–					
74	19:6329	OSTI; NTIS (US Sales Only)		DE94730460	
ETSU-T–					
04/00195/REP	19:6536	OSTI; NTIS (US Sales Only); INIS		DE94726336	
ETSU-W–					
35/00290/REP	19:6539	OSTI; NTIS (US Sales Only); INIS		DE94726334	
ETSU-WN–					
6056/016	19:6565	OSTI; NTIS (US Sales Only)		DE94730469	
6056/030	19:6541	OSTI; NTIS (US Sales Only); INIS		DE94730467	
ETSU-WV–					
1692	19:6537	OSTI; NTIS (US Sales Only)		DE94730470	
FEI–					
2182	19:7683	OSTI; NTIS (US Sales Only); INIS		DE94611293	
FEMP–					
2294	19:6272	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002554	MF-702
2297	19:6161	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004018	MF-700
2310	19:6273	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003187	MF-900
2311	19:6274	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003186	MF-702
FERC/FEIS–					
0067	19:6782	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003998	MF-402
FNAL-TM–					
1832	19:7261	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004652	MF-414
1834	19:7262	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004665	MF-414
1845	19:7263	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004661	MF-414
1861	19:7264	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004632	MF-414
1865	19:7319	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004631	MF-414
1869	19:7265	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004657	MF-406
FNAL/C–					
93-329-E	19:7628	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003643	MF-414
93.345-E	19:7631	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004663	MF-414
93/282	19:7570	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002303	MF-400
93/290-E	19:7316	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003620	MF-414
93/302-E	19:7317	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003642	MF-414
93/305	19:7624	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003363	MF-414
93/308	19:7218	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003645	MF-414
93/313-E	19:7625	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003618	MF-414
93/318	19:7318	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003644	MF-414
93/319-E	19:7657	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003617	MF-414
93/320-E	19:7626	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003641	MF-414
93/328	19:7627	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003619	MF-414
93/330-E	19:7629	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004655	MF-414
93/333	19:7630	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004651	MF-414
93/339	19:7354	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003640	MF-414
93/346	19:7539	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004662	MF-412
93/347-E	19:7632	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004658	MF-414
93/349-E	19:7633	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004654	MF-414
93/352-E	19:7634	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004664	MF-414
93/355-E	19:7658	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004656	MF-414
93/358-E	19:7635	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004659	MF-414
93/363-E	19:7636	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004660	MF-414
GA-A–					
21286	19:7823	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004185	MF-421
21426	19:7871	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004188	MF-420
21445	19:7872	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004184	MF-420
21485	19:7873	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003402	MF-420
21494	19:7874	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003403	MF-420
21507	19:7824	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004860	MF-420
GRI–					
93/0270	19:6090	*See* SAND–93-2239			

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GSF–					
15/93	19:6162	OSTI; NTIS (US Sales Only); INIS		DE94734090	
22/93	19:6163	OSTI; NTIS (US Sales Only); INIS		DE94734091	
GSF-TL–					
21/93	19:6163	*See* GSF–22/93			
GSI–					
93-23	19:7493	OSTI; NTIS (US Sales Only); INIS		DE94734094	
HEP-TH–					
9303168	19:7571	*See* BONN-HE–93-10			
9304013	19:7572	*See* BONN-HE–93-11			
9304083	19:7525	*See* BONN-HE–93-13			
9304096	19:7573	*See* DESY–93-051			
HIFAN–					
577	19:7886	*See* LBL–33798			
HW–					
3-1835	19:6694	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003506	MF-700
52860	19:6124	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003822	MF-520
58461	19:6134	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003755	MF-711
69071	19:6164	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003744	MF-600
72956	19:6165	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003743	MF-600
81295-8	19:6166	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000533	MF-700
81295-10	19:6167	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003740	MF-700
IAEA-INFCIRC–					
173(add.1)	19:6922	OSTI; NTIS (US Sales Only); INIS		DE94611053	
173(add.2)	19:6923	OSTI; NTIS (US Sales Only); INIS		DE94611054	
209(rev.1/mod.1/add.2)	19:6314	OSTI; NTIS (US Sales Only); INIS		DE94611049	
419	19:6305	OSTI; NTIS (US Sales Only); INIS		DE94611055	
IC–					
93/188	19:7574	OSTI; NTIS (US Sales Only); INIS		DE94611114	
93/200	19:7602	OSTI; NTIS (US Sales Only); INIS		DE94611152	
93/211	19:7575	OSTI; NTIS (US Sales Only); INIS		DE94611145	
93/221	19:7637	OSTI; NTIS (US Sales Only); INIS		DE94611208	
93/231	19:7638	OSTI; NTIS (US Sales Only); INIS		DE94611209	
93/233	19:7529	OSTI; NTIS (US Sales Only); INIS		DE94611075	
93/242	19:7659	OSTI; NTIS (US Sales Only); INIS		DE94611232	
93/252	19:7540	OSTI; NTIS (US Sales Only); INIS		DE94611100	
93/266	19:7054	OSTI; NTIS (US Sales Only); INIS		DE94610398	
93/267	19:7541	OSTI; NTIS (US Sales Only); INIS		DE94611101	
93/268	19:7542	OSTI; NTIS (US Sales Only); INIS		DE94611102	
93/269	19:7543	OSTI; NTIS (US Sales Only); INIS		DE94611103	
93/276	19:7544	OSTI; NTIS (US Sales Only); INIS		DE94611104	
ICSP–					
V2-TURFW-R	19:6732	*See* NUREG/IA–0110			
IFP–					
40719	19:6092	OSTI; NTIS (US Sales Only)		DE94728740	
40772	19:6093	OSTI; NTIS (US Sales Only)		DE94728741	
40783	19:6107	OSTI; NTIS (US Sales Only)		DE94728746	
40836	19:6094	OSTI; NTIS (US Sales Only)		DE94728748	
40849	19:6095	OSTI; NTIS (US Sales Only)		DE94728747	
IFP-RA–					
1992	19:6103	OSTI; NTIS (US Sales Only)		DE94728742	
IFSR–					
623-Rev.	19:7814	*See* DOE/ET/53088–623-Rev.			
627	19:7815	*See* DOE/ET/53088–627			
629	19:7816	*See* DOE/ET/53088–629			
632	19:7817	*See* DOE/ET/53088–632			
IFVE-OKU–					
92-145	19:7293	OSTI; NTIS (US Sales Only); INIS		DE94610768	
IFVE-OLU–					
91-104	19:7219	OSTI; NTIS (US Sales Only); INIS		DE94610738	
IFVE-OP–					
91-155	19:7220	OSTI; NTIS (US Sales Only); INIS		DE94610739	
IFVE-ORI–					
92-148	19:7266	OSTI; NTIS (US Sales Only); INIS		DE94610748	
IFVE-UNK–					
92-22	19:7221	OSTI; NTIS (US Sales Only); INIS		DE94610740	
IHEP-OMMS–					
92-52	19:7639	OSTI; NTIS (US Sales Only); INIS		DE94611174	
IHEP-OTF–					
92-149	19:7603	OSTI; NTIS (US Sales Only); INIS		DE94611160	
92-53	19:7660	OSTI; NTIS (US Sales Only); INIS		DE94611253	

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IKE–					
2-99	19:7407	OSTI; NTIS (US Sales Only)		DE94734010	
4-136	19:6720	OSTI; NTIS (US Sales Only); INIS		DE94734092	
IM–					
2928	19:7068	*See* NUTEK–89-3419			
IMES-EESS–					
9	19:6427	OSTI; NTIS; INIS		DE94730406	
INIS-GB–					
521	19:7474	OSTI; NTIS (US Sales Only); INIS		DE94610484	
INIS-RU–					
346	19:7494	OSTI; NTIS (US Sales Only); INIS		DE94610668	
INIS-XN–					
467	19:7960	OSTI; NTIS (US Sales Only); INIS		DE94609511	
468	19:6315	OSTI; NTIS (US Sales Only); INIS		DE94609510	
469	19:6316	OSTI; NTIS (US Sales Only); INIS		DE94609505	
475	19:6317	OSTI; NTIS; INIS		DE94611051	
INIS-mf–					
13733	19:7444	OSTI; NTIS (US Sales Only); INIS		DE94610480	
13734	19:7446	OSTI; NTIS (US Sales Only); INIS		DE94610481	
13735	19:6594	OSTI; NTIS (US Sales Only); INIS		DE94610800	
13736	19:6638	OSTI; NTIS (US Sales Only); INIS		DE94611050	
13740	19:6965	OSTI; NTIS (US Sales Only); INIS		DE94610232	
13741	19:7921	OSTI; NTIS (US Sales Only); INIS		DE94611058	
13742	19:7055	OSTI; NTIS (US Sales Only); INIS		DE94610393	
13745	19:6644	OSTI; NTIS (US Sales Only); INIS		DE94610957	
13759	19:7447	OSTI; NTIS (US Sales Only); INIS		DE94610461	
13761	19:7875	OSTI; NTIS; INIS		DE94611506	
13762	19:7267	OSTI; NTIS (US Sales Only); INIS		DE94610752	
INP-MSU–					
92-27-276	19:7604	OSTI; NTIS (US Sales Only); INIS		DE94611161	
92-34-283	19:7825	OSTI; NTIS (US Sales Only); INIS		DE94611496	
92-35-284	19:7717	OSTI; NTIS (US Sales Only); INIS		DE94611371	
92-42-291	19:7661	OSTI; NTIS (US Sales Only); INIS		DE94611254	
IPP–					
1/274	19:7876	OSTI; NTIS (US Sales Only); INIS		DE94734001	
3/189	19:7877	OSTI; NTIS (US Sales Only); INIS		DE94734002	
4/259	19:7268	OSTI; NTIS (US Sales Only); INIS		DE94734074	
5/51	19:7878	OSTI; NTIS (US Sales Only); INIS		DE94733999	
6/313	19:7826	OSTI; NTIS (US Sales Only); INIS		DE94734000	
IS–					
5085	19:7095	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005568	MF-940
IS-T–					
1614	19:7096	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005554	MF-401
1616	19:7119	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005277	MF-401
1631	19:7028	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004889	MF-401
1642	19:7790	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005558	MF-404
1644	19:7097	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005261	MF-401
1653	19:6966	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005562	MF-404
1654	19:7640	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005557	MF-414
1656	19:7098	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005556	MF-401
1657	19:7129	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005265	MF-401
1658	19:7099	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005555	MF-401
1660	19:6967	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005564	MF-401
1661	19:7029	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005260	MF-411
1664	19:7755	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005551	MF-414
1667	19:7100	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005548	MF-401
1668	19:7101	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005550	MF-401
1669	19:7056	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004888	
1673	19:7922	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005549	MF-405
1674	19:7130	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005553	MF-401
1682	19:7120	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004887	MF-404
1684	19:7576	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004886	MF-410
1687	19:7135	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004885	MF-401
1688	19:6968	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004883	MF-404
IVA-M–					
277	19:6796	OSTI; NTIS		DE94730426	
IVL-B–					
1106	19:7408	OSTI; NTIS		DE94730415	
1119	19:7476	OSTI; NTIS		DE94730429	
IYaF–					
91-110.	19:7616	*See* BUDKERINP–91-110			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
91-116.	19:7793	*See* BUDKERINP–91-116			
91-117.	19:7776	*See* BUDKERINP–91-117			
91-74.	19:7526	*See* BUDKERINP–91-74			
91-98.	19:7527	*See* BUDKERINP–91-98			
92-1.	19:7528	*See* BUDKERINP–92-1			
92-39.	19:7290	*See* BUDKERINP–92-39			
92-54	19:7222	OSTI; NTIS (US Sales Only); INIS		DE94610741	
92-57.	19:7595	*See* BUDKERINP–92-57			
92-58.	19:7794	*See* BUDKERINP–92-58			
92-60.	19:7795	*See* BUDKERINP–92-60			
92-61.	19:7617	*See* BUDKERINP–92-61			
JET-R–					
93-04	19:7827	OSTI; NTIS (US Sales Only); INIS		DE94611460	
JINR-D–					
2-92-552	19:7530	OSTI; NTIS (US Sales Only); INIS		DE94611076	
JINR-E–					
2-92-107	19:7577	OSTI; NTIS (US Sales Only); INIS		DE94611115	
2-92-115	19:7641	OSTI; NTIS (US Sales Only); INIS		DE94611210	
2-92-158	19:7662	OSTI; NTIS (US Sales Only); INIS		DE94611226	
2-92-168	19:7578	OSTI; NTIS (US Sales Only); INIS		DE94611146	
2-92-172	19:7579	OSTI; NTIS (US Sales Only); INIS		DE94611116	
2-92-176	19:7580	OSTI; NTIS (US Sales Only); INIS		DE94611117	
2-92-191	19:7581	OSTI; NTIS (US Sales Only); INIS		DE94611118	
2-92-195	19:7582	OSTI; NTIS (US Sales Only); INIS		DE94611147	
2-92-359	19:7531	OSTI; NTIS (US Sales Only); INIS		DE94611077	
2-92-502	19:7583	OSTI; NTIS (US Sales Only); INIS		DE94611148	
2-92-538	19:7584	OSTI; NTIS (US Sales Only); INIS		DE94611119	
2-92-556	19:7605	OSTI; NTIS (US Sales Only); INIS		DE94611150	
4-92-212	19:7678	OSTI; NTIS (US Sales Only); INIS		DE94611284	
4-92-542	19:7679	OSTI; NTIS (US Sales Only); INIS		DE94611259	
JINR-R–					
1-92-167	19:7320	OSTI; NTIS (US Sales Only); INIS		DE94610903	
11-92-409	19:7923	OSTI; NTIS (US Sales Only); INIS		DE94611059	
13-92-551	19:7587	OSTI; NTIS (US Sales Only); INIS		DE94611120	
2-92-154	19:7687	OSTI; NTIS (US Sales Only); INIS		DE94611324	
2-92-162	19:7663	OSTI; NTIS (US Sales Only); INIS		DE94611246	
2-92-170	19:7718	OSTI; NTIS (US Sales Only); INIS		DE94611341	
2-92-217	19:7642	OSTI; NTIS (US Sales Only); INIS		DE94611221	
2-92-505	19:7585	OSTI; NTIS (US Sales Only); INIS		DE94611111	
4-92-165	19:7680	OSTI; NTIS (US Sales Only); INIS		DE94611260	
4-92-166	19:7684	OSTI; NTIS (US Sales Only); INIS		DE94611317	
4-92-367	19:7586	OSTI; NTIS (US Sales Only); INIS		DE94611149	
4-92-496	19:7532	OSTI; NTIS (US Sales Only); INIS		DE94611078	
6-92-536	19:7685	OSTI; NTIS (US Sales Only); INIS		DE94611318	
JPL-PUBL–					
93-15	19:7910	*See* DOE/ER/25118–1			
Juel–					
2729	19:7502	OSTI; NTIS (US Sales Only); INIS		DE94734008	
2733	19:7643	OSTI; NTIS (US Sales Only); INIS		DE94734009	
2735	19:7294	OSTI; NTIS (US Sales Only); INIS		DE94734007	
2736	19:6481	OSTI; NTIS (US Sales Only)		DE94734006	
2739	19:6647	OSTI; NTIS (US Sales Only); INIS		DE94733998	
2760	19:7448	OSTI; NTIS (US Sales Only); INIS		DE94734098	
K/DSRD/FTR–					
170	19:7955	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004158	MF-700
K/TCD–					
1076	19:6168	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004841	MF-906
1089	19:6169	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004931	MF-902
KAERI/AR–					
352/92	19:6969	OSTI; NTIS (US Sales Only); INIS		DE94610233	
357/92	19:7503	OSTI; NTIS (US Sales Only); INIS		DE94610578	
362/93	19:6674	OSTI; NTIS (US Sales Only); INIS		DE94610796	
369/93	19:7138	OSTI; NTIS (US Sales Only); INIS		DE94610692	
370/93	19:7924	OSTI; NTIS (US Sales Only); INIS		DE94611060	
371/93	19:6653	OSTI; NTIS (US Sales Only); INIS		DE94610777	
375/93	19:6602	OSTI; NTIS (US Sales Only); INIS		DE94610814	
KAERI/TR–					
248/92	19:6671	OSTI; NTIS (US Sales Only); INIS		DE94610790	
253/92	19:6603	OSTI; NTIS (US Sales Only); INIS		DE94610815	
255/92	19:6624	OSTI; NTIS (US Sales Only); INIS		DE94610850	
266/92	19:6604	OSTI; NTIS (US Sales Only); INIS		DE94610816	

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268/92	19:6125	OSTI; NTIS (US Sales Only); INIS		DE94610791	
269/92	19:6318	OSTI; NTIS (US Sales Only); INIS		DE94610681	
270/92	19:6605	OSTI; NTIS (US Sales Only); INIS		DE94610817	
273/92	19:6654	OSTI; NTIS (US Sales Only); INIS		DE94610778	
275/92	19:6655	OSTI; NTIS (US Sales Only); INIS		DE94610779	
277/92	19:7925	OSTI; NTIS (US Sales Only); INIS		DE94611061	
278/92	19:7926	OSTI; NTIS (US Sales Only); INIS		DE94611062	
286/92	19:6672	OSTI; NTIS (US Sales Only); INIS		DE94610792	
293/92	19:6606	OSTI; NTIS (US Sales Only); INIS		DE94610818	
299/92	19:6675	OSTI; NTIS (US Sales Only); INIS		DE94610797	
304/92	19:6607	OSTI; NTIS (US Sales Only); INIS		DE94610819	
305/92	19:6648	OSTI; NTIS (US Sales Only); INIS		DE94610773	
316/92	19:6608	OSTI; NTIS (US Sales Only); INIS		DE94610820	
319/92	19:6649	OSTI; NTIS (US Sales Only); INIS		DE94610774	
320/92	19:6609	OSTI; NTIS (US Sales Only); INIS		DE94610821	
324/93	19:7102	OSTI; NTIS (US Sales Only); INIS		DE94610090	
325/92	19:6610	OSTI; NTIS (US Sales Only); INIS		DE94610822	
328/92	19:6135	OSTI; NTIS (US Sales Only); INIS		DE94610197	
329/93	19:6611	OSTI; NTIS (US Sales Only); INIS		DE94610823	
330/92	19:6673	OSTI; NTIS (US Sales Only); INIS		DE94610793	
331/93	19:6612	OSTI; NTIS (US Sales Only); INIS		DE94610824	
332/93	19:6613	OSTI; NTIS (US Sales Only); INIS		DE94610825	
336/92	19:6614	OSTI; NTIS (US Sales Only); INIS		DE94610826	
345/93	19:6656	OSTI; NTIS (US Sales Only); INIS		DE94610780	
353/93	19:7927	OSTI; NTIS (US Sales Only); INIS		DE94611063	
354/93	19:6615	OSTI; NTIS (US Sales Only); INIS		DE94610827	
358/93	19:6645	OSTI; NTIS (US Sales Only); INIS		DE94610771	
362/93	19:6646	OSTI; NTIS (US Sales Only); INIS		DE94610772	
367/93	19:7533	OSTI; NTIS (US Sales Only); INIS		DE94611079	
KCL-KUITU–					
13	19:6881	OSTI; NTIS		DE94702090	
16	19:6882	OSTI; NTIS		DE94702092	
KCP–					
613-5310	19:6883	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002423	MF-706
KFK–					
5060	19:7879	OSTI; NTIS (US Sales Only); INIS		DE94734059	
5068	19:7360	OSTI; NTIS (US Sales Only)		DE94734012	
5082	19:6626	OSTI; NTIS (US Sales Only); INIS		DE94734066	
5104	19:7880	OSTI; NTIS (US Sales Only); INIS		DE94734013	
5117	19:7103	OSTI; NTIS (US Sales Only); INIS		DE94734011	
5120	19:7177	OSTI; NTIS (US Sales Only); INIS		DE94734060	
5126	19:6805	OSTI; NTIS (US Sales Only); INIS		DE94734101	
5149	19:7146	OSTI; NTIS (US Sales Only); INIS		DE94734058	
5154	19:7449	OSTI; NTIS (US Sales Only)		DE94733997	
5177	19:6970	OSTI; NTIS (US Sales Only); INIS		DE94734065	
5197	19:6783	OSTI; NTIS (US Sales Only)		DE94734100	
KFKI–					
1993-02/G	19:6650	OSTI; NTIS (US Sales Only); INIS		DE94610775	
1993-07/B	19:7534	OSTI; NTIS (US Sales Only); INIS		DE94611080	
1993-08/A	19:7588	OSTI; NTIS (US Sales Only); INIS		DE94611112	
1993-09/B	19:7535	OSTI; NTIS (US Sales Only); INIS		DE94611081	
1993-10/G	19:7545	OSTI; NTIS (US Sales Only); INIS		DE94611105	
1993-11/A	19:7719	OSTI; NTIS (US Sales Only); INIS		DE94611162	
1993-13/A	19:7664	OSTI; NTIS (US Sales Only); INIS		DE94611227	
LA–					
12538-MS	19:7504	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003509	MF-907
12552-MS	19:7178	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003577	MF-361
12596-MS	19:6237	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004880	MF-814
12604-MS	19:7748	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004204	MF-700; MF-000
12633-MS	19:7321	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002888	MF-700
12635-T	19:7644	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003537	MF-414
12637-T	19:6971	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005402	MF-404
12644-M	19:7546	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004470	
12651-T	19:7736	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003376	MF-413
12663-T	19:7645	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003895	MF-410
12666-M	19:7322	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003171	MF-700
12676-MS	19:6170	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003872	MF-940
12677-MS	19:7323	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005605	MF-414
12678-MS	19:7324	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005604	MF-410
12679-MS	19:7325	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005606	MF-414

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12684-MS	19:7057	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004191	
12685-MS	19:6972	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004189	
12691-T	19:7737	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005617	MF-410
12701-MS	19:6171	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005243	MF-940
LA-SUB–					
93-131	19:6721	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002569	MF-131
93-263	19:7384	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002566	
94-1	19:7295	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005666	MF-705
LA-UR–					
92-1507	19:7928	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004996	
93-1963	19:7477	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003576	MF-902
93-2080	19:7367	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE93016604	
93-2783	19:6306	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE93040265	MF-700; MF-000
93-2784	19:6307	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE93040264	MF-700; MF-000
93-2848	19:6308	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000813	MF-940
93-2860	19:6309	OSTI; NTIS; GPO Dep.	E 1.99:	DE93040254	MF-706
93-2861	19:6310	OSTI; NTIS; GPO Dep.	E 1.99:	DE93040253	MF-704
93-2862	19:6311	OSTI; NTIS; GPO Dep.	E 1.99:	DE93040252	MF-706
93-3077	19:6172	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002641	MF-721
93-3281	19:7133	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003980	MF-701; MF-704
93-3283	19:7514	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000900	
93-3423	19:6312	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000816	MF-706
93-3424	19:6173	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000886	
93-3461	19:7929	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000687	
93-3462	19:6657	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000686	
93-3489	19:6174	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000676	MF-940
93-3528	19:7326	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003979	
93-3548	19:6683	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002627	
93-3566	19:7900	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002623	MF-700
93-3588	19:7327	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003977	
93-3595	19:6632	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002635	MF-528
93-3614	19:7030	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002646	MF-414
93-3625	19:6275	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002644	MF-700
93-3642	19:6276	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002710	MF-903
93-3647	19:7881	OSTI; INIS; NTIS; GPO Dep.	E 1.99:	DE94003976	MF-424
93-3651	19:6633	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002716	
93-3655	19:7882	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003975	MF-424
93-3665	19:7883	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002713	MF-420
93-3666	19:6277	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002712	MF-700
93-3667	19:6722	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002721	
93-3695	19:6529	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002717	MF-251
93-3707	19:7328	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003973	
93-3726	19:6634	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002691	
93-3748	19:7329	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003972	MF-940
93-3914	19:7930	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003966	MF-905
93-3920	19:7592	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003965	MF-413
93-3930	19:7104	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003963	
93-3951	19:7518	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003961	MF-405
93-3966	19:6973	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003959	MF-701
93-3967	19:7058	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003958	MF-701
93-3981	19:6974	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003957	MF-721
93-3992	19:7450	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003956	MF-721
93-4000	19:7409	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003955	MF-902
93-4093	19:6175	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003942	
93-4102	19:7931	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003941	MF-905
93-4107	19:7489	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003940	MF-908
93-4108	19:6925	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003939	
93-4147	19:7607	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003936	MF-413
93-4161	19:6176	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003935	
93-4173	19:7548	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003934	MF-412
93-4185	19:7549	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003933	MF-706
93-4210	19:7490	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003932	MF-408
93-4224	19:7410	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003930	MF-902; MF-905
93-4230	19:7031	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004995	MF-365
93-4234	19:7884	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004993	MF-424
93-4251	19:7932	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004990	MF-705
93-4257	19:6322	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004987	MF-414

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
93-4262	19:7550	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004986	
93-4265	19:7519	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004985	MF-706
93-4274	19:7059	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004982	MF-404
93-4279	19:7551	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004981	MF-700
93-4313	19:7552	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004977	MF-700
93-4315	19:7593	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005011	MF-410
93-4316	19:7536	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005010	MF-414
93-4326	19:7032	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005009	MF-404
93-4340	19:7553	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005006	
93-4343	19:7060	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005005	MF-370
93-4397	19:7554	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005156	
93-4406	19:7555	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004999	
93-4482	19:7885	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005015	MF-410
93-4521	19:6975	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005013	MF-904
LAMP–					
93/3	19:7547	OSTI; NTIS (US Sales Only); INIS		DE94611106	
LAPP-AL–					
391-92	19:7589	OSTI; NTIS (US Sales Only); INIS		DE94611121	
404-92	19:7590	OSTI; NTIS (US Sales Only); INIS		DE94611122	
408-92	19:7591	OSTI; NTIS (US Sales Only); INIS		DE94611123	
LBL–					
30043	19:6177	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003377	PC-800
30751	19:7520	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004006	MF-403
31791	19:7756	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005211	MF-404
31792	19:7121	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004011	MF-404
33440	19:7269	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003259	MF-414
33456	19:7210	*See* SLAC-PUB–6312			
33594	19:7190	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004555	MF-414
33798	19:7886	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005216	MF-415
33808	19:7933	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004934	MF-405
33943	19:6847	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004935	MF-350
33967	19:7330	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003890	MF-404
33991	19:7331	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004554	MF-413
33998	19:7332	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005207	MF-414
34017	19:6976	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005215	MF-404
34018	19:6977	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003406	MF-404
34019	19:6978	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003415	MF-404
34022	19:7333	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003886	MF-404
34124-Rev.	19:7179	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003245	MF-405
34231	19:7887	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003255	MF-415
34259	19:7088	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004941	PC-401
34433	19:7191	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003262	MF-404
34460	19:7451	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004936	MF-800
34488	19:7227	*See* SLAC-PUB–6326			
34512-Summ.	19:7495	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004014	MF-405
34556	19:7296	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003988	MF-414
34603	19:7270	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003408	MF-410
34663	19:7334	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004003	MF-410
34670	19:7271	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003419	MF-410
34722	19:7202	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004556	
34724	19:7738	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003242	MF-413
34726	19:7646	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003409	MF-414
34728	19:7744	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003248	MF-404
34730	19:7272	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003420	MF-410
34736	19:7203	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003476	PC-411
34738	19:7647	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004002	MF-414
34763	19:7061	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003247	MF-404
34767	19:7147	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003499	PC-411
34774	19:6501	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003411	MF-250
34776	19:7273	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004013	MF-406
34783	19:7556	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005214	MF-412
34793	19:6979	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004558	MF-404
34795	19:6980	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003414	MF-404
34813	19:7335	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003887	MF-414
34819	19:7934	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003413	MF-405
34832	19:7336	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004559	
34836	19:7223	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004937	MF-414
34837	19:7204	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004938	MF-414
34838	19:7452	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005205	MF-403
34872	19:7122	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004203	MF-413
34875	19:7062	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004939	MF-401

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
34876	19:6486	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004940	MF-350
34897	19:7484	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005204	MF-408
34899	19:7337	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005208	MF-414
34903	19:7485	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005210	MF-408
34908	19:6981	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005213	MF-404
34909	19:6982	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005202	MF-404
34918	19:7131	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005217	MF-401
LBL-PUB–					
5375	19:6797	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003453	MF-400
5379	19:7297	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004812	MF-414
LITH-MAT-R–					
93-30	19:6861	OSTI; NTIS		DE94730444	
LIU-TEK-LIC–					
93-5	19:7956	OSTI; NTIS		DE94730422	
93-18	19:6582	OSTI; NTIS		DE94730423	
LIYaF–					
1765	19:7648	OSTI; NTIS (US Sales Only); INIS		DE94611171	
LRAP–					
133	19:7411	OSTI; NTIS		DE94730427	
LRP–					
477/93	19:7828	OSTI; NTIS; INIS		DE94611467	
479/93	19:7829	OSTI; NTIS; INIS		DE94611447	
480/93	19:7830	OSTI; NTIS; INIS		DE94611468	
481/93	19:7831	OSTI; NTIS; INIS		DE94611489	
482/93	19:7832	OSTI; NTIS; INIS		DE94611448	
484/93	19:7833	OSTI; NTIS; INIS		DE94611498	
485/93	19:7834	OSTI; NTIS; INIS		DE94611461	
LUNBDS-NBKE–					
92-5002	19:7478	OSTI; NTIS		DE94730411	
LUNKDL-NKOO–					
1022	19:6839	OSTI; NTIS		DE94730404	
LUTFD2-TFEM–					
93-1003	19:6784	OSTI; NTIS; INIS		DE94730405	
93-1005	19:6831	OSTI; NTIS		DE94730420	
LUTMDN-TMVK–					
5221	19:7187	OSTI; NTIS		DE94730414	
5224	19:6899	OSTI; NTIS		DE94730446	
7014	19:6914	OSTI; NTIS		DE94730447	
NEDO-C–					
9212	19:6080	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732341	
NEDO-P–					
9205	19:6820	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732335	
9207	19:6919	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732336	
9211	19:6530	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732337	
9224	19:6460	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732338	
9228	19:6920	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732339	
9255	19:6829	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE94732340	
NEI-DK–					
1353	19:6809	OSTI; NTIS		DE94730158	
1354	19:6826	OSTI; NTIS		DE94730214	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
1355	19:6900	OSTI; NTIS		DE94730215	
1356	19:6849	OSTI; NTIS		DE94730216	
1360	19:6850	OSTI; NTIS		DE94730342	
1363	19:6489	OSTI; NTIS		DE94730344	
1364	19:6884	OSTI; NTIS		DE94730343	
1365	19:6487	OSTI; NTIS		DE94730345	
1366	19:6448	OSTI; NTIS		DE94730346	
1368	19:6901	OSTI; NTIS		DE94730318	
1369	19:6490	OSTI; NTIS		DE94730347	
1371	19:6814	OSTI; NTIS		DE94730328	
1373-Vol.1	19:6798	OSTI; NTIS		DE94730319	
1373-Vol.2	19:6799	OSTI; NTIS		DE94730320	
1387	19:7412	OSTI; NTIS		DE94730329	
1388	19:6407	OSTI; NTIS		DE94730336	
1389	19:6885	OSTI; NTIS		DE94730335	
1390	19:6851	OSTI; NTIS		DE94730337	
1391	19:7413	OSTI; NTIS		DE94730327	
NEI-NO–					
383	19:6790	OSTI; NTIS		DE94730364	
NEI-SE–					
126	19:6061	OSTI; NTIS; INIS		DE94730416	
128	19:7414	OSTI; NTIS; Available from: Chalmers Univ. of Technology, Dept. of Chemical Environmental Science, S-412 96 Gothenburg, Sweden		DE94730407	
129	19:7415	OSTI; NTIS; Available from: Chalmers Univ. of Technology, Dept. of Chemical Environmental Science, S-412 96 Gothenburg, Sweden		DE94730408	
130	19:7416	OSTI; NTIS; Available from: Chalmers Univ. of Technology, Dept. of Chemical Environmental Science, S-412 96 Gothenburg, Sweden		DE94730409	
131	19:6802	OSTI; NTIS		DE94730424	
132	19:6753	OSTI; NTIS		DE94730425	
135	19:6852	OSTI; NTIS		DE94002062	
137	19:6540	OSTI; NTIS; INIS		DE94730421	
NESC–					
1140	19:7920	*See* ESTSC/NRC/R–000372IBMPC00			
1147	19:7918	*See* ESTSC/NRC/R–000316IBMPC00			
9864	19:7917	*See* ESTSC/NRC/R–000098C017600			
9888	19:7919	*See* ESTSC/NRC/R–000322I037000			
NIIYaF-MGU–					
92-27-276.	19:7604	*See* INP-MSU–92-27-276			
92-31-280	19:7558	OSTI; NTIS (US Sales Only); INIS		DE94610504	
92-34-283.	19:7825	*See* INP-MSU–92-34-283			
92-35-284.	19:7717	*See* INP-MSU–92-35-284			
92-39-288	19:7888	OSTI; NTIS (US Sales Only); INIS		DE94611509	
92-42-291.	19:7661	*See* INP-MSU–92-42-291			
92-7-256	19:7338	OSTI; NTIS (US Sales Only); INIS		DE94610922	
92-9-258	19:7557	OSTI; NTIS (US Sales Only); INIS		DE94610505	
NILU-OR–					
27/93	19:7417	OSTI; NTIS		DE94730351	
NIPER–					
661	19:6087	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000112	PC-122
714	19:6088	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000111	PC-122
724	19:6082	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000110	PC-122
727	19:6089	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005200	MF-122
NRCN(TN)–					
146	19:7064	OSTI; NTIS (US Sales Only); INIS		DE94610395	
NREL/CP–					
410-6033	19:6469	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000236	MF-276
NREL/TP–					
411-5800	19:6470	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000219	MF-270
411-6003	19:6471	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000260	MF-270
411-6010	19:6472	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000248	MF-270
411-6046	19:6473	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000257	MF-270
411-6047	19:6474	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000249	MF-270
411-6110	19:6475	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000258	MF-270
413-6216	19:6476	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000259	MF-271
425-6162	19:6862	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000245	MF-335
430-5597	19:6424	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000262	MF-245
451-5746	19:6477	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000250	MF-273
461-5478	19:6810	OSTI; NTIS; GPO Dep.	E 1.99:	DE93018230	MF-233

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
NUREG–					
0540-Vol.15-No.10	19:6639	OSTI; NTIS; INIS; GPO		TI94004758	
0713-Vol.14	19:7505	OSTI; NTIS; INIS; GPO		TI94005256	
0750-Vol.38-No.4	19:6723	OSTI; NTIS; INIS; GPO		TI94004512	
1272-Vol.7-No.2	19:6278	OSTI; NTIS; INIS; GPO		TI94003428	
1377-Rev.4	19:6658	OSTI; NTIS; INIS		TI94005259	
1427	19:6616	OSTI; NTIS; INIS; GPO		TI94005199	
1487-Vol.1	19:7957	OSTI; NTIS; INIS; GPO		TI94004202	
NUREG/CR–					
4832-Vol.8	19:6724	OSTI; NTIS; INIS; GPO		TI94003922	
5360	19:6725	OSTI; NTIS; INIS; GPO		TI94004195	
5897	19:6620	OSTI; NTIS; INIS; GPO		TI94005185	
5901-Final	19:6726	OSTI; NTIS; INIS		TI94004213	
5907	19:6727	OSTI; NTIS; INIS; GPO		TI94003580	
5949	19:6728	OSTI; NTIS; INIS; GPO		TI94004046	
5995	19:6729	OSTI; NTIS; INIS; GPO		TI94003823	
6025	19:6730	OSTI; NTIS; INIS		TI94003993	
6062	19:7339	OSTI; NTIS; INIS; GPO		TI94004757	
6101	19:6731	OSTI; NTIS; INIS; GPO		TI94004215	
6117	19:6697	OSTI; NTIS; INIS; GPO		TI94005266	
NUREG/GR–					
0010	19:7958	OSTI; NTIS; INIS; GPO		TI94004214	
NUREG/IA–					
0110	19:6732	OSTI; NTIS; INIS; GPO		TI94005017	
NUTEK–					
87-4937	19:6983	OSTI; NTIS		DE94730436	
89-1157	19:6984	OSTI; NTIS		DE94730437	
89-1791	19:7418	OSTI; NTIS		DE94730443	
89-3419	19:7068	OSTI; NTIS		DE94730438	
89-4195	19:6118	OSTI; NTIS		DE94730439	
90-696	19:6764	OSTI; NTIS		DE94730440	
91-173	19:7480	OSTI; NTIS		DE94730441	
91-51917	19:6059	OSTI; NTIS		DE94730412	
91-52291	19:6863	OSTI; NTIS		DE94730442	
NUTEK-R–					
92-3	19:6112	OSTI; NTIS		DE94730432	
NUTEK-VK–					
93-16	19:6583	OSTI; NTIS		DE94730430	
93-17	19:6896	OSTI; NTIS		DE94730431	
93-19	19:6425	OSTI; NTIS		DE94730413	
NYSERDA–					
93-14	19:6853	OSTI; New York State Energy Research and Development Authority, Two Rockerfeller Plaza, Albany, New York 12223		TI94003721	
ORNL–					
6781	19:6362	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004726	MF-242
ORNL/ER–					
197	19:6178	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004746	MF-902
209	19:6179	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004790	MF-902
ORNL/ER/Sub–					
87-99053/55	19:6279	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003516	MF-902
ORNL/FTR–					
4663	19:6040	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018198	MF-114
4673	19:6985	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93017909	
4675	19:6622	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93017911	MF-522
4678	19:7682	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000510	MF-413
4683	19:7340	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93018608	MF-413
4702	19:7033	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93019177	MF-404
4740	19:6319	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000753	MF-520
4748	19:6928	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000505	MF-332
4759	19:7781	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000983	MF-411
4769	19:6854	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94000982	MF-350
4785	19:7835	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002185	MF-420
4815	19:6323	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002469	MF-411
4819	19:7034	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94002195	MF-330
4843	19:7836	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003791	MF-420
4849	19:7837	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004871	MF-420
4852	19:6811	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004465	MF-350
4863	19:7274	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004461	MF-406
ORNL/M–					
3027	19:6815	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004180	MF-630

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
ORNL/M–					
3156	19:6782	*See* FERC/FEIS–0067			
ORNL/SUB–					
88-SC423/01	19:7069	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004544	MF-114
88-SM362/1	19:6757	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003578	MF-201
ORNL/TM–					
12379	19:6864	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004929	MF-405
12391	19:6627	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003811	PC-530
12440	19:7935	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004256	MF-700; MF-705
12484	19:6697	*See* NUREG/CR–6117			
12625	19:7105	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003475	MF-404
12629	19:6324	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005471	MF-411
PATENTS-US–					
A7758065	19:6041	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003061	MF-109
A7762966	19:7275	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003057	MF-414
A7767603	19:7368	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003050	MF-706
A7770386	19:6126	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003518	MF-523; MF-520
A7779473	19:6055	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003039	MF-113
A7798781	19:7192	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005173	MF-704
A7798782	19:7537	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005172	MF-414
A7804555	19:6865	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005163	MF-406
A7813727	19:7791	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005157	MF-704
A7814355	19:7792	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005152	MF-704
PCMDI–					
12	19:7521	*See* UCRL-ID–115322			
PETC–					
94005180	19:6008	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005180	MF-113; MF-132
PIYaF–					
1800	19:7757	OSTI; NTIS (US Sales Only); INIS		DE94611521	
1804	19:7758	OSTI; NTIS (US Sales Only); INIS		DE94611522	
1814	19:7759	OSTI; NTIS (US Sales Only); INIS		DE94611523	
PNL–					
7974	19:6855	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004569	MF-350
8104	19:6620	*See* NUREG/CR–5897			
8659	19:6180	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004566	MF-810
8848	19:6181	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003469	MF-721
8853	19:6182	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004586	MF-810
8884	19:6238	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004300	MF-902
8926	19:6986	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003470	MF-404
8930	19:6909	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004568	MF-350
8935	19:7453	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003677	MF-902
8945	19:7454	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004567	MF-605
8950	19:6794	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004754	MF-400
8958	19:7455	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004587	
8959	19:7341	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004565	MF-606
8967	19:6183	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004805	MF-510
8981	19:6280	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005179	MF-607
PNL-SA–					
20608	19:6184	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004591	MF-902
20825	19:7456	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004288	MF-902
21257	19:6185	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004316	MF-902
21411	19:6186	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004287	MF-510
21630	19:7035	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004589	
21660	19:6758	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004354	MF-202
21725	19:6987	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004308	MF-404
21736	19:6988	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004359	MF-423
21753	19:6989	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003867	MF-404
21757	19:6484	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003727	MF-406
21769	19:7936	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004318	MF-901; MF-905
21839	19:6187	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004317	MF-603; MF-607
21958	19:6804	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004360	MF-500
22009	19:7937	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004293	
22076	19:6188	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004358	MF-902
22101	19:7342	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004362	MF-607
22122	19:6189	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004769	MF-500
22124	19:6538	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004355	MF-261
22175	19:6812	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004364	MF-920

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
22232	19:7106	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003717	MF-500
22307	19:7374	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004365	MF-406
22351	19:7419	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004356	MF-402
22357	19:6281	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003723	MF-902
22386	19:6190	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004592	MF-902
22393	19:6282	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004299	MF-903
22406	19:6926	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003703	MF-706
22408	19:6927	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004270	MF-904
22411	19:7343	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004593	MF-706; MF-705
22412	19:7740	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004719	MF-505
22415	19:7148	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004597	MF-905
22432	19:6191	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004598	MF-721
22435	19:6990	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003808	MF-423
22442	19:6991	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004367	MF-423
22444	19:6992	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004264	MF-420
22456	19:7889	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004368	MF-423
22470	19:7890	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004307	MF-423
22489	19:7891	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003810	MF-423
22505	19:6192	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004763	MF-502
22525	19:7070	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004371	MF-401
22526	19:6993	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004269	MF-423
22545	19:7892	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004290	MF-423
22561	19:7071	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004312	
22644	19:6856	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004266	MF-310
22649	19:6193	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004760	MF-902
22654	19:6840	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002954	MF-114
22661	19:6042	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002955	MF-108
22666	19:7123	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004315	MF-401
22667	19:6043	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002953	MF-401
22668	19:6994	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004599	MF-423
22677	19:7457	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004291	MF-902
22707	19:7686	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004720	MF-414
22721	19:6194	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004286	MF-940
22737	19:7901	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003729	MF-500
22739	19:7107	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003730	MF-506
22813	19:7741	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004774	MF-413
22894	19:6816	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003720	MF-505
22915	19:7938	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004777	MF-405
22941	19:6995	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004268	MF-404
23016	19:6996	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004596	MF-404
23053	19:7959	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003719	MF-500
23064	19:6827	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004260	MF-405
23116	19:7939	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003704	MF-405
23122	19:6773	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003705	MF-402
23135	19:7124	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004295	MF-401
23141	19:6195	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004294	MF-902
23284	19:7036	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004787	MF-504
23361	19:6897	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004781	MF-902
23363	19:6283	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004594	MF-906
23419	19:7893	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004779	MF-423
PNWD–					
1980-13-HEDR	19:7458	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004755	
2200-HEDR	19:7506	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002952	
2218-HEDR-Draft	19:6239	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004756	
2222-HEDR-Draft	19:6240	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005492	
2223-HEDR-Draft	19:6241	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005572	
PPPL–					
2945	19:7894	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005544	PC-420
2948	19:7838	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005545	PC-420
2951	19:7839	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005541	PC-427
2952	19:7840	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005537	PC-426; PC-427
2953	19:7841	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005539	PC-420; PC-427
2956	19:7842	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005538	PC-421
PSI–					
117	19:6598	OSTI; NTIS; INIS		DE94610805	
PSI-PROC–					
93-01	19:7760	OSTI; NTIS (US Sales Only); INIS		DE94611406	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
RFP–					
4745	19:6284	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94000994	MF-700
4747	19:7507	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001391	MF-702
4748	19:6285	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000993	MF-610
RL-NRD–					
827	19:6684	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003745	MF-711
RT/AMB–					
91-18	19:7403	*See* ENEA-RT-AMB–91-18			
92-04	19:6581	*See* ENEA-RT-AMB–92-04			
92-08	19:7473	*See* ENEA-RT-AMB–92-08			
92-11	19:7404	*See* ENEA-RT-AMB–92-11			
92-12	19:7501	*See* ENEA-RT-AMB–92-12			
92/03	19:6160	*See* ENEA-RT-AMB–92-03			
RT/ENERG–					
92-01	19:6480	*See* ENEA-RT-ENERG–92-01			
92-02	19:6898	*See* ENEA-RT-ENERG–92-02			
SAND–					
89-0943	19:6725	*See* NUREG/CR–5360			
91-2111	19:6196	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003676	MF-902
92-1107	19:7355	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004685	MF-704
92-1108	19:7356	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004684	MF-704
92-1422-Final	19:6726	*See* NUREG/CR–5901-Final			
92-1563	19:6727	*See* NUREG/CR–5907			
92-1911	19:6197	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005263	MF-902
92-2662C	19:7369	OSTI; NTIS; GPO Dep.	E 1.99:	DE93040054	MF-741
92-2909	19:7357	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003136	MF-706
92-7328	19:6198	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003674	MF-901; MF-902
93-0429C	19:6242	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005098	MF-903
93-0574C	19:7072	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003785	MF-704
93-0579C	19:7073	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003773	MF-704; MF-706
93-0871	19:7940	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005077	MF-705
93-0893	19:6730	*See* NUREG/CR–6025			
93-0925	19:6730	*See* NUREG/CR–6025			
93-1076	19:7183	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005315	MF-706
93-1092C	19:6599	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001599	
93-1099C	19:6997	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004798	MF-704
93-1146C	19:6998	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002289	MF-704
93-1159C	19:7125	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003771	MF-406
93-1171C	19:6999	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002849	MF-706
93-1203C	19:6733	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001603	MF-700
93-1235C	19:7375	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001826	MF-700
93-1236C	19:7376	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001825	MF-700
93-1253C	19:6734	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003232	
93-1256C	19:7365	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002920	MF-700
93-1272C	19:6199	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004675	MF-940
93-1298C	19:7149	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002924	MF-706
93-1321C	19:6735	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001544	MF-700
93-1323C	19:7193	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003709	
93-1358	19:7205	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003673	MF-706
93-1377	19:6736	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004681	
93-1419C	19:7150	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003109	MF-700
93-1453C	19:7074	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003769	MF-411
93-1471C	19:7075	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004690	MF-404
93-1475	19:6737	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004679	
93-1493C	19:7076	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004693	MF-404
93-1498C	19:6738	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003712	
93-1509C	19:7194	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004799	MF-704
93-1529C	19:7077	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004692	MF-704
93-1533C	19:6491	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003489	MF-237
93-1606C	19:6670	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003106	
93-1720	19:7000	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003672	MF-405
93-1802C	19:6044	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001212	MF-108
93-1822	19:7151	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005289	MF-706
93-1870C	19:7195	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003711	MF-706
93-1888	19:6286	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002610	MF-902
93-1900	19:6566	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004678	MF-261
93-1953	19:7185	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003137	MF-122
93-2007	19:7037	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005206	MF-904
93-2088	19:7377	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003689	MF-700

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
93-2133	19:7152	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003688	MF-705
93-2168C	19:7001	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004691	MF-704
93-2171C	19:7941	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001597	MF-705
93-2173C	19:7378	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001830	MF-700
93-2205C	19:7002	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003804	MF-704
93-2218C	19:6739	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003233	
93-2239	19:6090	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005291	
93-2296C	19:6635	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002933	MF-706
93-2297C	19:6740	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003229	
93-2334C	19:7003	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004695	MF-235
93-2378	19:7139	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005320	PC-900
93-2383C	19:6741	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001423	
93-2417	19:7078	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005316	MF-704
93-2419C	19:7942	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001602	MF-706
93-2420C	19:7943	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001601	MF-700
93-2495C	19:7038	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003767	MF-704
93-2504C	19:6485	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003713	MF-235
93-2512C	19:7895	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003774	MF-712
93-2514C	19:7126	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005096	MF-701
93-2542C	19:7079	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002734	MF-704
93-2545C	19:7039	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003798	
93-2568C	19:7370	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003102	MF-705
93-2571	19:7153	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005318	MF-706
93-2595C	19:7944	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003107	MF-705
93-2596C	19:7945	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003103	MF-705
93-2597C	19:7946	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003108	MF-705
93-2599C	19:7420	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002649	MF-706
93-2616C	19:7481	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002922	
93-2663C	19:6924	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002685	MF-900
93-2678C	19:7080	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003802	MF-706
93-2682C	19:7081	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003722	MF-701
93-2696C	19:6636	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94003789	
93-2742C	19:7154	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003803	MF-905
93-3807	19:7947	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005319	MF-705
93-3825C	19:7082	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004672	MF-704
93-3826C	19:7083	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004671	MF-704
93-7098	19:6478	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004676	MF-237
93-7112C	19:7127	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005100	MF-901
93-7113C	19:6200	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005099	MF-901
93-8015	19:6243	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005080	MF-402
93-8237	19:7004	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001166	MF-704
93-8245	19:6623	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004275	MF-1020
94-8475C	19:7005	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004976	MF-404
SC-MAG–					
418	19:7269	*See* LBL–33440			
SCIPP–					
93/36	19:7609	*See* ANL-HEP-CP–93-52			
SIEMENS-KWU-U9–					
414/88/027	19:6742	OSTI; NTIS (US Sales Only); INIS		DE94734003	
SJF-BERETNING–					
55	19:6857	OSTI; NTIS		DE94730332	
SLAC–					
418	19:7297	*See* LBL-PUB–5379			
SLAC-PUB–					
4252	19:7276	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003464	MF-414
5843	19:7206	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003462	MF-414
5906	19:7344	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005241	MF-414
5970	19:7345	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003461	MF-414
5983	19:7277	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003460	MF-414
6052	19:7224	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003459	MF-414
6096	19:7649	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003457	MF-414
6127	19:7207	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005242	MF-414
6159	19:7208	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005240	MF-414
6167	19:7278	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003456	MF-414
6194	19:7279	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003455	MF-414
6201	19:7280	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005239	MF-414
6202	19:7225	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005238	MF-414
6203	19:7281	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005237	MF-414
6204	19:7226	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005236	MF-414
6262	19:7282	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003452	MF-414

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SLAC-PUB–					
6267	19:7346	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003451	MF-406
6292	19:7650	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003446	MF-414
6293	19:7209	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003441	MF-414
6296	19:7283	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003439	MF-414
6312	19:7210	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005235	MF-414
6313	19:7211	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003435	MF-414
6316	19:7665	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003442	MF-414
6326	19:7227	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003443	MF-414
6329	19:7666	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005234	MF-414
6332	19:7228	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003444	MF-414
6334	19:7212	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003445	MF-414
6340	19:7667	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003432	MF-414
6347	19:7668	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005233	MF-414
6352	19:7347	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005232	MF-414
6354	19:7669	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005231	MF-414
6355	19:7213	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003430	MF-414
6362	19:7651	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003450	MF-414
6376	19:7348	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003448	MF-414
6378	19:7652	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005225	MF-414
6380	19:7284	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003447	MF-414
6384	19:7608	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005230	MF-414
6387	19:7285	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005227	MF-414
SNL/NM–					
699795-7	19:6642	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002874	MF-502; MF-523
SP–					
93-16	19:6492	OSTI; NTIS		DE94730450	
93-17	19:6493	OSTI; NTIS		DE94730451	
93-18	19:6858	OSTI; NTIS		DE94730433	
93-22	19:6859	OSTI; NTIS		DE94730434	
93-36	19:6465	OSTI; NTIS		DE94730452	
93-40	19:6860	OSTI; NTIS		DE94730435	
SR/H–					
589	19:7364	*See* DPSZ–7890			
662	19:6127	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004706	MF-500
663-Del.Ver.	19:6128	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004705	MF-700
664	19:6698	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004704	MF-706
666	19:6120	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004702	MF-500
SRI–					
2847-21	19:6034	*See* DOE/PC/91053–T5			
SRT-ATS–					
930104	19:7948	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004944	MF-705
SSCL–					
651	19:7286	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004273	MF-414
654	19:7229	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004330	MF-414
SSCL-Preprint–					
516	19:7349	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003981	MF-400
520	19:7287	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003378	MF-414
535	19:7350	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003590	MF-414
SSCL-SR–					
1228	19:7288	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004274	MF-414
SVF–					
476	19:7006	OSTI; NTIS		DE94730448	
478	19:7155	OSTI; NTIS		DE94730449	
TA–					
309	19:6847	*See* LBL–33943			
TFB–					
91-18	19:7418	*See* NUTEK–89-1791			
93-5	19:6866	OSTI; NTIS		DE94730428	
TRITA-FTE–					
93-3	19:7040	OSTI; NTIS; INIS		DE94608744	
TRITA-MAK-LA–					
93-1	19:6583	*See* NUTEK-VK–93-16			
TRITA-MEK-TR–					
93-10	19:7180	OSTI; NTIS		DE94730445	
TRITA-VBI–					
162	19:6462	OSTI; NTIS		DE94730403	
UCID–					
21245-Vol.8	19:6724	*See* NUREG/CR–4832-Vol.8			
21336-Rev.1	19:7421	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003668	

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UCRL–					
52000-93-7	19:6912	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004219	PC-700
UCRL-CR–					
114339	19:6136	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003621	MF-707
115038	19:7156	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004209	MF-700
UCRL-ID–					
106454-93-4	19:6313	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004337	MF-700
110051	19:7459	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003878	MF-702
112129-Rev.1	19:7422	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005649	MF-706
114055	19:7297	*See* LBL-PUB–5379			
114570	19:7181	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005314	MF-704
114715	19:7371	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003863	MF-704; MF-706
114839	19:6731	*See* NUREG/CR–6101			
114849	19:7157	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003370	MF-706
114900	19:7386	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004806	MF-500
115027	19:7158	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004807	MF-507
115099-Rev.1	19:7949	OSTI; NTIS; GPO Dep.	E 1.99:	DE94005293	MF-705
115160	19:6750	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004808	MF-900
115208	19:6287	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004809	MF-500
115234	19:6743	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94004686	MF-1002
115283	19:7379	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003667	MF-706
115322	19:7521	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004276	MF-702
115334	19:7513	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004279	MF-702; MF-706
115335	19:7522	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004280	MF-702
115480	19:7896	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004028	MF-700
115497	19:7843	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004281	MF-421
115681	19:7380	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004226	MF-700
115904	19:7897	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004810	MF-420
UCRL-JC–					
112576	19:7366	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94001610	MF-700
112788	19:7523	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003624	MF-703; MF-702
112926	19:7739	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003637	MF-414
113059	19:7460	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003627	MF-702; MF-707
113295	19:7372	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004867	MF-701
113553	19:7902	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001634	MF-900
113769	19:7041	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004212	MF-704
113809	19:7136	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002023	MF-900
113838	19:7486	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004336	MF-708
114200	19:7381	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001764	MF-731
114506	19:7358	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004019	MF-704
114725	19:7084	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003639	MF-904
114791	19:6201	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004349	MF-814
114841	19:7085	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004865	MF-704
115045	19:7423	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003626	MF-702; MF-707
115068	19:7508	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004199	MF-707
115071	19:7509	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004198	MF-707
115085	19:7424	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002986	MF-707
115243	19:7903	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003369	MF-707
115244	19:7904	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003368	MF-900
115269	19:7382	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001765	MF-706; MF-731
115297	19:6288	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004020	MF-402
115309	19:7359	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004211	MF-706
115318	19:7950	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004351	MF-705
115318-Rev.1	19:7951	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004350	MF-705
115320	19:7137	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003662	MF-701
115381	19:7487	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004335	MF-708
115404	19:7383	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE94001606	MF-700
115410	19:7159	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001605	MF-700
115411	19:6289	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001611	MF-722
115601	19:7952	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004334	MF-705
115616	19:7898	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003622	MF-706; MF-712
115682	19:7196	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003638	MF-906
115684	19:7559	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003635	MF-900

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115702	19:7560	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004186	MF-700
UCRL-LR–					
115188	19:7425	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004272	PC-712
UFIFT-HEP–					
93-24	19:7563	*See* DOE/ER/40272–194			
UH–					
511-775-93	19:7609	*See* ANL-HEP-CP–93-52			
USGS-OFR–					
92-450	19:6202	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003605	MF-814
USGS-WRI–					
92-4065	19:7461	OSTI; NTIS; GPO; U.S. Geological Survey, Books and Open-File Reports Section, Box 25425, Mail Stop 517, Federal Center, Denver, CO 80225-0425; GPO Dep.	E 1.99:	DE94003606	MF-814
UTS-DFT–					
93-20.	19:7637	*See* IC–93/221			
UTSI–					
93-03	19:6834	*See* DOE/ET/10815–208			
UVA–					
527418/MANE94/101	19:6689	*See* DOE/ER/12983–1			
WAPD-T–					
2944	19:7160	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004449	MF-506
2947	19:7184	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004023	MF-500
2949	19:6651	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004450	MF-500
2956	19:7186	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004451	MF-500
2966	19:6744	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003725	MF-523
2969	19:6600	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004448	MF-506
2973	19:7007	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004447	MF-506
WHC-EP–					
0415-Rev.1	19:6203	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003873	MF-900
0468-2	19:6290	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004845	MF-902
0474-9	19:6204	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004824	MF-940
0573-1	19:6244	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003328	MF-902
0672	19:6291	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003467	MF-940
0678	19:6205	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004895	MF-902
0689	19:6245	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004894	MF-600
WHC-MR–					
0400	19:6292	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004495	MF-902; MF-906
0437	19:6121	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004825	MF-900; MF-901
0440	19:6129	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005425	MF-940
0451	19:6628	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005487	MF-940
WHC-SA–					
1576	19:6206	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004491	MF-940
1907	19:6246	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004484	MF-903
1946	19:6293	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003093	MF-902
2116	19:6207	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003468	MF-940
2163	19:6294	OSTI; NTIS; GPO Dep.	E 1.99:	DE94003503	MF-900
2172	19:6208	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004480	MF-902
2180	19:6209	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003492	MF-940
2189	19:6295	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003491	MF-907; MF-940
WHC-SD-EN-SPP–					
003	19:6296	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004410	MF-903
WHC-SD-NR-TRP–					
016	19:7086	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004828	MF-904
WHC-SD-W026-SDRD–					
001-Rev.3	19:6210	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004932	MF-810
WHC-SD-W026-TA–					
001	19:7426	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003529	MF-940
WHC-SD-W100-ICD–					
001	19:6211	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004933	MF-721
WHC-SD-WM-FRD–					
011	19:6297	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004257	MF-940
WHC-SP–					
0665-8	19:7462	OSTI; NTIS; GPO Dep.	E 1.99:	DE94002654	MF-600
WINCO–					
1125	19:7087	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000723	MF-906
WSRC-MS–					
92-144	19:6212	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003871	MF-701

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92-475	19:6745	OSTI; NTIS; GPO Dep.	E 1.99:	DE93019833	MF-707
93-084	19:6746	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003122	MF-706
93-168	19:7953	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94001190	MF-700
93-245	19:6298	OSTI; NTIS; GPO Dep.	E 1.99:	DE93040722	MF-707
93-336	19:6130	OSTI; NTIS; GPO Dep.	E 1.99:	DE94001191	MF-700
93-353	19:6747	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE93013587	MF-700
93-362-Rev.1	19:7463	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004033	MF-902
93-470	19:6213	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002528	MF-700
93-518	19:6214	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003856	MF-721
93-519	19:6215	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94002940	MF-721
93-529	19:6216	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003852	MF-721
WSRC-RP–					
92-984	19:6299	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005139	MF-702
93-1177	19:6218	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003708	MF-721; MF-704
93-1206	19:6219	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004038	MF-721
93-1217	19:6220	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004037	MF-702
93-1260	19:6221	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004024	MF-721
93-1304	19:6222	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94005516	MF-721
93-1378	19:6223	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004435	MF-721
93-890	19:6300	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94003907	MF-702; MF-721
93-941-Rev.1	19:6217	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004027	MF-702
WSRC-TR–					
92-1205-Rev.1	19:6225	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004025	MF-721
92-427-Rev.2	19:6224	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004039	MF-721
93-100-5	19:6699	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004438	MF-700
93-316	19:6226	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004902	MF-702
93-328	19:6227	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004898	MF-721
93-347-Rev.1	19:6301	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004440	MF-707; MF-721
93-393	19:7464	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004441	MF-702
93-394	19:7465	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004030	MF-702
93-398	19:7466	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004444	MF-702
93-461	19:6228	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94004446	MF-704; MF-721
93-464	19:6700	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004026	MF-706
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TN Tunisia
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TZ Tanzania, United Republic of

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UG Uganda
US United States
UY Uruguay
UZ Uzbekistan

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VC Saint Vincent and the Grenadines
VE Venezuela
VN Viet Nam
VU Vanuatu

WS Samoa

YE Yemen, Republic of
YU Yugoslavia

ZA South Africa
ZM Zambia
ZR Zaire
ZW Zimbabwe

Codes for International Organizations

ED EANDC [European American Nuclear Data Committee]
EP European Patent Office
IO ILO [International Labor Organization]
IX IUPAC [International Union of Pure and Applied Chemistry]
QS INSPEC [Information Service in Physics, Electrotechnology and Control]
QZ INPADOC [International Patent Document Centre]
WO WIPO [World Intellectual Property Organization]
XA IAEA [International Atomic Energy Agency]
XC CERN [European Organization for Nuclear Research]
XD OECD [Organization for Economic Co-Operation and Development]
XE CEC [Commission of the European Communities]
XF FAO [Food and Agricultural Organization of the United Nations]
XH AAEA [Arab Atomic Energy Agency]
XI IIASA [International Institute for Applied Systems Analysis]
XJ JINR [Joint Institute for Nuclear Research]
XK WMO [World Meteorological Organization]
XN NEA [Nuclear Energy Agency of the OECD]
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XR ICRP [International Commission on Radiological Protection]
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